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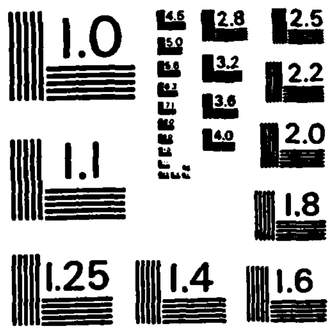

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KWIK SMOKE OBSCURATION MODEL:

USER'S GUIDE

September 1982

by

Ricardo Peña

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US Army Electronics Research and Development Command
Atmospheric Sciences Laboratory
White Sands Missile Range, NM 88002

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ASL-TR-0120	2. GOVT ACCESSION NO. AD-A121542	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) KWIK SMOKE OBSCURATION MODEL: USER'S GUIDE		5. TYPE OF REPORT & PERIOD COVERED R&D Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ricardo Pena		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Atmospheric Sciences Laboratory White Sands Missile Range, New Mexico 88002		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DA task No. 1L162111AH71A2
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Electronics Research and Development Command Adelphi, MD 20783		12. REPORT DATE September 1982
		13. NUMBER OF PAGES 151
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Algorithms Computers Smoke screens Obscuration Munition expenditure Mnemonics		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The KWIK smoke obscuration model, developed by the Atmospheric Sciences Laboratory, is available in eight versions. The following desktop computers are used to run the KWIK algorithms: HP9830A, HP9825A (with three versions), HP85, HP9845, and the APPLE II. A FORTRAN IV version is also available. All of these versions are basically the same, with the exception of the volume of fire table version, which runs on the HP9825A. This version produces munition		

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INTRODUCTION

The KWIK smoke obscuration model has been described in an earlier report.[1] The algorithm has been developed from well-known and easily used principles of micrometeorology, atmospheric optics, turbulence, and diffusion. The general approach for formulating the model is based upon a study by Downs[2] for the atmospherics optics portion, Gaussian plume and puff hypotheses as discussed by Gifford[3] and Pasquill,[4] and atmospheric stability criteria extracted from Pasquill,[5] Turner,[6] and Smith.[7]

The KWIK algorithm is designed to calculate munition expenditures for finite screen lengths and times, based upon ambient meteorological conditions, as a function of the optical pathlength from observer to target. The diffusion portion of the model treats both semi-continuous point source plumes and quasi-instantaneous point source puffs. Chemically generated military smokes considered are hexachloroethane (HC) and bulk white phosphorus (WP).

Munition expenditure estimates are presented in terms of the following parameters:

Weapons system/number,
Screen length in meters,
Screen duration in minutes,
Rate of fire (in rounds/minute),

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[1] Umstead, R. K., R. Pena, and F. V. Hansen, KWIK: An Algorithm for Calculating Munition Expenditures for Smoke Screening/Obscuration in Tactical Siturations, ASL-TR-0030, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 1979.

[2] Downs, A. R., A Review of Atmospheric Transmission Information in the Optical and Microwave Spectral Regions, Report 2710, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, 1976.

[3] Gifford, F. A., Jr., "An Outline of Theories of Diffusion in the Lower Layers of the Atmosphere," Meteorology and Atomic Energy (D. H. Slade, ed), US Atomic Energy Commission, Washington, DC, 1968.

[4] Pasquill, F., Atmospheric Diffusion, 2nd Ed., Halsted Press, Division of John Wiley & Sons, New York, 1974.

[5] Pasquill, F., "The Estimation of the Dispersion of Windborne Material," Meteorol Mag, Vol, 90, 1961.

[6] Turner, D. B., "A Diffusion Model for Urban Area," J Appl Meteorol, 3:83, 1964.

[7] Smith, F. B., "A Scheme for Estimating the Vertical Dispersion of a Plume from a Source Near Ground-Level," 1973 (unpublished Meteorological Office Note).

Impact separations from adjustment point,
Number of rounds to establish screen,
Number of rounds to maintain screen, and
Total expenditures.

The KWIK algorithm is available in eight versions:

HP 9830A with printer output
HP 9825A with printer output,
HP 9825A CRT version,
Fortran IV version,
HP 85 with printer output,
HP 9845 with printer output,
HP 9825A volume of fire table, and
APPLE II version.

All the algorithms except the volume of fire table version are very similar.

The specifications of the storage medium required by each computer that uses the KWIK algorithms are as follows:

(a) The HP 9830A uses a Hewlett-Packard digital cassette number 9162-0050 or equivalent. The data or program storage capacity is 64,000 bytes. The information on the cassette tape may be protected by removing or sliding both tabs to the top of the cassette so that an opening at each end is created.

(b) The HP 9825A uses a Hewlett-Packard tape cartridge number 9162-0061 or equivalent. The tape is structured with two tracks (0 and 1), which may be used to store programs, data, and instructions for special function keys. The storage capacity of the tape cartridge is 225,000 bytes. To prevent erasures, the record slide tab must be in the leftmost position.

(c) On the UNIVAC 1108 or equivalent (FORTRAN IV Version) the KWIK algorithm may be stored on standard IBM computer cards, card image mass storage, or magnetic tape units compatible with the computer being used.

(d) The HP 85 and 9845 use the same tape cartridge used with the HP 9825. Programs are stored in 256-byte physical records. The maximum number of bytes per record is 32,767.

(e) On the APPLE II a 5-in floppy disk (capacity 931,000 bits) is used to load and store the KWIK algorithm. An APPLE computer with APPLE Disk II, DOS Version 3.2.1 is used.

USER'S INSTRUCTIONS

This section of the user's guide is divided into eight parts, to provide instructions for calculating munition expenditure estimates for the eight versions of the KWIK algorithm.

Part 1: HP 9830A Version

The algorithm has been prepared in BASIC language for the HP 9830A programmable desk calculator, which must contain a String Variable Read Only Memory (ROM) and a minimum of 3808 words of Random Access Memory (RAM). The KWIK program is recorded on cassette tape files 0 through 3. After inserting the cassette in the loader and rewinding the tape, the first file (file 0) is loaded by executing the command "LOAD 0." When the file has been loaded, press the "RUN" and "EXECUTE" buttons. The type of format used for the required inputs is query/response. The "EXECUTE" button is depressed after each program input entry. At the end of each file execution the calculator display will show "LINK (File No.)." The "LINK (File No.)" command will load the corresponding file, conserving the values of the parameters in common throughout the program.

The program inputs are in the following query/response sequence:

SITE PARAMETERS

(1) Site identification, four characters;

(2) Latitude, in degrees and tenths;

(3) Direction from equator, North (N) or South (S);

(4) Longitude, in degrees and tenths;

(5) Direction from Greenwich, East (E) or West (W);

(6) Altitude above MSL, kilometers and tenths;

(7) Julian date, three digits;

(8) Greenwich Civil time, nearest hour;

METEOROLOGICAL PARAMETERS

(9) Ceiling height, feet;

(10) Cloud cover, percent;

(11) Visibility, miles;

(12) Precipitation (Yes = 1; No = 0);

(13) Ambient air temperature, degrees Fahrenheit;

(14) Dewpoint temperature, degrees Fahrenheit

(15) Wind direction, degrees;

(16) Windspeed, knots;

SCENARIO PARAMETERS

(17) Average roughness element, centimeters;

(18) Slant range to target, kilometers;

(19) Angle (with the horizontal) of sight to target, degrees;

(20) Direction (from north) of line of sight, degrees;

(21) Smoke screen length, meters; and

(22) Smoke screen duration, minutes.

All English input units are converted by the program to the metric system. The algorithm also calculates the relative humidity in percent and the Pasquill stability category (A through F).

The program outputs are displayed on the HP9866A printer after the execution of each file. The output sequence is listed in the sample computation shown in tables 1 through 5. For visible and near infrared wavelengths the munition expenditures (impact separations for initial and sustaining volleys for the 105- and 155-mm howitzers) are displayed on the printer for HC and WP smoke. The mid and far infrared wavelength expenditures are printed only for WP smoke. The output will also list the number of guns required for initial and sustaining volleys, the rate of fire in rounds per minute, and the total rounds required. The number rounds required per 60-m unit screen length are printed for the mid and far infrared wavelengths.

Appendix A lists a glossary of mnemonics for identifying the BASIC language symbology used by the HP-9830A KWIK program. Given in Appendix B is the BASIC program listing.

Part 2: HP 9825A Printer Output Version

Th KWIK algorithm has also been programmed in the Hewlett-Packard Language (HPL) for the HP 9825A programmable calculator. The site, meteorological and scenario input parameters are identical to those of part 1, with the following exceptions:

(9) Ceiling height, meters;

(11) Visibility, kilometers;

(13) Ambient air temperature, degrees Celsius; and

(14) Dewpoint temperature, degrees Celsius.

In order to execute the program, the HP 9825A calculator must contain the following ROMS: String, Advanced Programming, and General I/O; also a minimum of 23,228 bytes of RAM is required. The KWIK program is recorded on data cartridge track 0, file 3. It may be recorded on other files of track 0 or 1 as a redundancy backup option.

After the cartridge is inserted in the loader, the program is loaded by depressing the "LOAD" and then the number 3 or by typing in the characters "ldf3" and then depressing the "EXECUTE" key. Once the program file has been loaded, press the "RUN" key. The query/response method is used for the input parameters. The "CONTINUE" key must be depressed after each entry. The program outputs are displayed on the paper tape printer, integral to the HP 9825A calculator, in the same sequence as shown in tables 1 through 5. A glossary of mnemonics appears in appendix C, and the program listing as appendix D.

Part 3: The HP 9825A CRT Version

The CRT version program is designed for solution on the HP 9825A programmable calculator using the following peripherals: (1) HP 1350A Graphics Translator and HP 1311A Display (CRT) and (2) HP 9871 Impact Printer. The input parameters are identical to those listed for the HP 9830A (part 1).

In order to execute the algorithm, the calculator must contain the String, Advanced Programming, and General I/O ROMs and a minimum of 23,228 bytes of RAM. As in the HP 9825A Printer version, the algorithm for the CRT version of KWIK is recorded on tape cartridge track 0, file 3. It may also be recorded on other files of tracks 0 or 1 as a redundancy backup option. The tape cartridge is loaded and the algorithm executed in the same manner as described in part 2.

The output of the KWIK program is displayed on the HP 1311A Display (CRT) and the HP 9871A printer. First to be displayed on the CRT are the list of inputs and the calculated stability category and relative humidity value. To continue viewing the output simply press "CONTINUE." (The calculator will display "CONTINUE WHEN READY.") For visible and near infrared wavelengths, the munition expenditure data (shell spacing for initial and sustaining volleys for 105- and 155-mm howitzers) is displayed for HC and WP smoke. The mid and far infrared wavelength data are displayed for WP smoke only. The output will also display the number of guns required for initial and sustaining volleys, the rate of fire in rounds per minute, and the total number of smoke rounds required. The number of rounds required per 60-m shell spacing (for 105- and 155-mm howitzers) are displayed for mid and far infrared wavelengths. At the end of the displayed output, the operator has the option of ending the program output or printing it on the HP 9871A printer. (The calculator will display, "0 TO EXIT - 1 to PRINT.") Pressing a "1" will cause the printer to print the same output displayed on the CRT. A sample of this output is listed in tables 1 through 5. Appendices E and F contain the HPL CRT KWIK glossary of mnemonics and the HPL program listing, respectively.

Part 4: The FORTRAN Version

The FORTRAN version of the KWIK algorithm is programmed in FORTRAN IV language and can be executed on most FORTRAN V compatible computers. The 22 inputs are

identical to those described in Part 1. The format for all input parameters (IBM card or card image input) is F10.0, with the following exceptions, which have a character format (a maximum of four characters):

(1) Site identification,

(3) Direction from equator,

(5) Direction from Greenwich, and

(12) Precipitation.

All inputs are converted by the program to the metric system. The algorithm also calculates the relative humidity in percent and the Pasquill stability category (A through F).

The computer output is displayed in the same fashion as shown for the HP 9825A CRT KWIK in tables 1 through 5. Appendix G shows a glossary of the FORTRAN mnemonics and appendix H contains a listing of the FORTRAN algorithm.

Part 5: HP 85 Version

The HP 85 desktop computer is the most compatible with the KWIK algorithm. It is fully integrated (keyboard, CRT display, CPU, magnetic tape unit, and thermal printer) in one small package, with 32K bytes of extended memory. The KWIK version for the HP85 is programmed in BASIC language.

The program is loaded into memory from an HP 200 or equivalent data cartridge by pressing the "LOAD" key and then typing "KWIK0" (or "KWIK1"), followed by pressing the "END LINE" key. To run the program, press the "RUN" key. The query/response method is then used to enter the 22 program inputs, as listed in part 1.

The output is displayed on the HP 85's own 4.5-in wide printer in the same fashion as shown in tables 1 through 5. Appendix I lists a glossary of mnemonics for identifying the BASIC language symbology used by the HP 85 KWIK algorithm. Appendix J shows the corresponding KWIK BASIC program listing.

Part 6: HP 9845 Version

The HP 9845 KWIK version is a BASIC algorithm similar to the HP 85 version. The program may be loaded into memory from a mass storage device, such as T15, the standard mass storage device for the HP 9845. Insert the magnetic tape cartridge in the T15 slot, press the "LOAD" key, type the "KWIK 45" file name, and press the "EXECUTE" key. To run the program, press the "RUN" key, and the query/response method is then used to enter the 22 program inputs, as listed in part 1.

The output is printed on the internal 80-character line printer unless a "PRINTER IS select code [, HP-IB device address]" command is executed from either the program or the keyboard. (The select code identifies the type of device at the specified address.) Select code 16 is used for the CRT. If an

external printer is desired, its corresponding select code and HP-IB device address must be used. Appendix I contains a glossary of mnemonics for the BASIC HP 9845 algorithm, and appendix K contains the corresponding KWIK program listing.

Part 7: The APPLE II version of KWIK is programmed in Applesoft BASIC language. It is almost identical to the HP85 and HP9845 versions. The APPLE Disk II, with 931,000 bits capacity, is used to load the algorithm in the APPLE computer memory (65K bytes capacity). This is done by typing the words "LOAD KWIK" and depressing the "RETURN" key. To run the program, "RUN" and "RETURN" are pressed. As with the other versions, the query/response method is used to enter the 22 inputs listed in part 1, with the following exceptions: (3) North = 1 and South = -1, and (5) West = 1 and East = -1.

The output may be displayed on any CRT screen or printer external to the APPLE II.

Appendix I lists a glossary of mnemonics identifying the APPLE II BASIC language symbology. Some minor differences between APPLE II and HP BASIC are noted. Appendix L contains a listing of the APPLE II BASIC algorithm.

Part 8: Volume of Fire Tables

The algorithm that produces munition expenditure tables is programmed (in HPL) for the HP 9825A programmable calculator. The algorithm requires the use of the same RAM and ROMs used for the other HP 9825A versions of KWIK (see part 3). The volume of fire tables algorithm is recorded on tape cartridge track 0, file 6. It may also be recorded on other files of tracks 0 or 1 as a backup option.

The tape cartridge is loaded and the algorithm executed in the same manner as described in part 2. The only required inputs are those for ambient temperature (degrees Fahrenheit) and relative humidity. Seven other meteorological and site parameters are fixed, but can easily be changed. The choices of relative humidity input values are 15, 40, and 80. After entering the relative humidity value (15 is the default if none is entered) and depressing the "CONTINUE" key, volume of fire tables for 105- and 155-mm howitzers are printed on the HP 9871 Impact Printer for HC WP smoke for visible and near infrared wavelengths.

The tables printed for HC smoke contain seven screen lengths ranging from 200 to 2,000 m and duration of effective smoke screen ranging from 5 to 35 min. For WP smoke the tables show five screen lengths ranging from 100 to 600 m and the duration of effective smoke from 5 to 25 min. Each Pasquill stability category (A through F) is shown with its respective windspeed in knots. The munition expenditures (volume of fire) data are computed in number of (105 or 155-mm howitzer) rounds for quartering wind. Rounds in area shown as $$$ exceed rate of fire of weapon or battery. Tables 6 through 8 show samples of the output produced by the volume of fire algorithm for HC and WP smoke (for 72°F temperature and 15, 40, and 80 percent relative humidity). Appendices M and N, respectively, show a list of the algorithm mnemonics and the program listing in HPL language for the volume of fire tables version.

ADDENDUM

SPECIAL NOTE

Under certain atmospheric conditions, an output of "0 rounds" may result. This output indicates that no smoke munitions are required for screening, due to such conditions as atmospheric absorption, haze and fog, or precipitation. When certain versions of the KWIK algorithm are used in these situations, a warning signal may be encountered as the computer attempts to print the output. The following additions to the indicated KWIK algorithms will avert such warning signals.

HP 9830A: Line "455 L(I,K) = 0" on file 3 (shell spacing - WP smoke)

HP 85: Line "4975 L(I,K) = 0"

HP 9845: Line "4195 L(I,K) = 0"

APPLE II: Line "2765 L(I,K) = 0"

TABLE 1. BASIC INPUT PARAMETERS FOR KWIK ALGORITHM

MUNITION EXPENDITURES
FOR HC AND WP SMOKE

ID		=	WSD
LATITUDE	- DEG	=	N 32.00
LONGITUDE	- DEG	=	W106.00
ALTITUDE	- KM	=	1.30
JULIAN DATE	- DAY	=	236
ZULU TIME	- HOUR	=	15
CEILING	- METERS	=	3048.00
CLOUD COVER	- PERCENT	=	20.00
VISIBILITY	- KM	=	40.25
PRECIPITATION		=	NO
TEMPERATURE	- DEG C	=	22.22
DEW POINT	- DEG C	=	18.61
WIND DIRECTION	- DEG	=	270.00
WIND SPEED	- KNOTS	=	15.00
AVE ROUGHNESS ELEMENT	- CM	=	74.00
PASQUILL STABILITY CATEGORY		=	D
RELATIVE HUMIDITY		=	80.03

TABLE 2. MUNITION EXPENDITURES FOR VISIBLE WAVELENGTHS

VISIBLE:

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

HC SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	19		21	
SUSTAINING:	19	0.5	21	95

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	3		138	
SUSTAINING:	3	0.5	138	15

WP SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	5		90	
SUSTAINING:	5	3.0	90	150

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	2		269	
SUSTAINING:	2	3.0	269	30

TABLE 3. MUNITION EXPENDITURES FOR NEAR INFRARED WAVELENGTHS

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

HC SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	50		8	
SUSTAINING:	50	0.5	8	250

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	8		52	
SUSTAINING:	8	0.5	52	40

WP SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	6		77	
SUSTAINING:	6	3.0	77	180

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	2		230	
SUSTAINING:	2	3.0	230	30

TABLE 4. MUNITION EXPENDITURES FOR MID INFRARED WAVELENGTHS

MID IR:

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

WP SMOKE SCREEN

	ROUNDS/ 60 METERS	RATE/ MINUTE	TOTAL ROUNDS
105MM:	4	3.0	890
155MM:	2	3.0	445

TABLE 5. MUNITION EXPENDITURES FOR FAR INFRARED WAVELENGTHS

FAR IR:

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

WP SMOKE SCREEN

	ROUNDS/ 60 METERS	RATE/ MINUTE	TOTAL ROUNDS
105MM	6	3.0	1334
155MM:	2	3.0	445

TABLE 6A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; 10%< RELATIVE HUMIDITY <20%

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	105mm HOWITZER																											
A/ 5	38	75	113	150	150	225	300	375	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	43	85	128	170	170	255	340	425	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	48	95	143	190	185	278	370	463	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	60	120	180	240	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	15	30	45	60	60	90	120	150	85	128	170	213	173	230	288	345	210	280	350	420	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
F/ 6	5	10	15	20	20	30	40	50	30	45	60	75	60	80	100	120	75	100	125	150	150	188	225	263	200	250	300	350

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	155mm HOWITZER																											
A/ 5	10	20	30	40	35	53	70	88	50	75	100	125	98	130	163	195	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	10	20	30	40	35	53	70	88	50	75	100	125	98	130	163	195	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	10	20	30	40	35	53	70	88	50	75	100	125	98	130	163	195	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	10	20	30	40	40	60	80	100	55	83	110	138	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	4	6	9	11	11	16	21	26	16	24	31	39	31	41	51	61	39	51	64	76	72	90	107	125	92	115	137	160
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	13	15	18	20	21	26	31	36	29	34	39	44	42	50	57	65

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6B. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; 10%< RELATIVE HUMIDITY <20%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	60	120	180	240	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	45	90	135	180	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350
F/ 6	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	23	45	68	90	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	15	30	45	60	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103
F/ 6	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6C. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; 10%< RELATIVE HUMIDITY <20%

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	105mm HOWITZER																											
A/ 5	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	43	85	128	170	165	248	330	413	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
F/ 6	18	35	53	70	65	98	130	163	95	143	190	238	195	260	325	390	240	320	400	480	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	155mm HOWITZER																											
A/ 5	20	40	60	80	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	20	40	60	80	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	23	45	68	90	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	25	50	75	100	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	8	15	23	30	25	38	50	63	35	53	70	88	75	100	125	150	90	120	150	180	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
F/ 6	4	6	9	11	11	16	21	26	17	25	32	40	32	42	52	62	34	44	54	64	65	80	95	110	87	107	127	147

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6D. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; 10%< RELATIVE HUMIDITY <20%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	45	90	135	180	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	15	30	45	60	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

TABLE 7A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; 21%< RELATIVE HUMIDITY <59%

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	105mm HOWITZER																											
A/ 5	30	60	90	120	115	173	230	288	175	263	350	438	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	33	65	98	130	130	195	260	325	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	35	70	105	140	140	210	280	350	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	43	85	128	170	170	255	340	425	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	13	25	38	50	45	68	90	113	65	98	130	163	128	170	213	255	158	210	263	315	310	388	465	543	$$$	$$$	$$$	$$$
F/ 6	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	54	71	89	106	110	138	165	193	141	176	211	246

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	155mm HOWITZER																											
A/ 5	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	90	120	150	180	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	98	130	163	195	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	90	120	150	180	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	8	15	23	30	30	45	60	75	40	60	80	100	83	110	138	165	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	4	6	9	11	11	16	21	26	12	17	22	27	25	32	40	47	26	33	41	48	54	67	79	92	65	80	95	110
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	13	15	18	20	15	17	20	22	29	34	39	44	33	38	43	48

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 7B. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; 21%< RELATIVE HUMIDITY <59%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	45	90	135	180	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	30	60	90	120	60	120	180	240	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350
F/ 6	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	23	45	68	90	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	15	30	45	60	23	45	68	90	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	8	15	23	30	15	30	45	60	23	45	68	90	60	90	120	150	$$$	$$$	$$$	$$$
D/15	15	30	45	60	30	60	90	120	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103
F/ 6	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE

TABLE 7C. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; 21%< RELATIVE HUMIDITY <59%

105mm HOWITZER

SCREEN (M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY																												
A/ 5	68	135	203	270	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	80	160	240	320	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	88	175	263	350	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	30	60	90	120	115	173	230	288	175	263	350	438	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
F/ 6	13	25	38	50	45	68	90	113	65	98	130	163	135	180	225	270	165	220	275	330	330	413	495	578	$$$	$$$	$$$	$$$

155mm HOWITZER

SCREEN (M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY																												
A/ 5	15	30	45	60	60	90	120	150	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	15	30	45	60	60	90	120	150	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	18	35	53	70	65	98	130	163	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	20	40	60	80	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	5	10	15	20	20	30	40	50	25	38	50	63	53	70	88	105	68	90	113	135	130	163	195	228	$$$	$$$	$$$	$$$
F/ 6	4	6	9	11	11	16	21	26	13	18	23	28	26	33	41	48	28	35	43	50	47	57	67	77	69	84	99	114

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 7D. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; 21%< RELATIVE HUMIDITY <59%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	60	120	180	240	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	45	90	135	180	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	23	45	68	90	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	15	30	45	60	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE

TABLE 8A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; RELATIVE HUMIDITY >60%

105mm HOWITZER

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY																												
A/ 5	18	35	53	70	70	105	140	175	105	158	210	263	210	280	350	420	263	350	438	525	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	20	40	60	80	80	120	160	200	115	173	230	288	233	310	388	465	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	20	40	60	80	80	120	160	200	120	180	240	300	240	320	400	480	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	25	50	75	100	95	143	190	238	140	210	280	350	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	8	15	23	30	25	38	50	63	35	53	70	88	68	90	113	135	83	110	138	165	170	213	255	298	220	275	330	385
F/ 6	4	6	9	11	11	16	21	26	17	25	32	40	26	33	41	48	34	44	54	64	65	80	95	110	87	107	127	147

155mm HOWITZER

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY																												
A/ 5	5	10	15	20	16	24	31	39	26	39	51	64	46	61	76	91	61	81	101	121	112	140	167	195	$$$	$$$	$$$	$$$
B/ 8	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	60	80	100	120	110	138	165	193	$$$	$$$	$$$	$$$
C/10	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	53	70	88	105	110	138	165	193	$$$	$$$	$$$	$$$
D/15	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	60	80	100	120	110	138	165	193	$$$	$$$	$$$	$$$
E/ 8	4	6	9	11	7	10	12	15	8	11	13	16	18	23	28	33	19	24	29	34	36	44	51	59	47	57	67	77
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	13	15	18	20	15	17	20	22	20	23	25	28	24	27	29	32

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF FIRE OF WEAPON BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 8B. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; RELATIVE HUMIDITY >60%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	38	75	113	150	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	45	90	135	180	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	30	60	90	120	60	120	180	240	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	30	60	90	120	45	90	135	180	60	120	180	240	150	225	300	375	$$$	$$$	$$$	$$$
E/ 8	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350
F/ 6	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	10	20	30	40	15	30	45	60	25	50	75	100	60	90	120	150	$$$	$$$	$$$	$$$
B/ 8	8	15	23	30	15	30	45	60	23	45	68	90	60	90	120	150	$$$	$$$	$$$	$$$
C/10	8	15	23	30	15	30	45	60	15	30	45	60	45	68	90	113	60	90	120	150
D/15	15	30	45	60	8	15	23	30	15	30	45	60	30	45	60	75	45	68	90	113
E/ 8	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103
F/ 6	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 8C. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - HC SMOKESCREEN; RELATIVE HUMIDITY >60%

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	105mm HOWITZER																											
A/ 5	40	80	120	160	160	240	320	400	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	45	90	135	180	180	270	360	450	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	50	100	150	200	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	63	125	188	250	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	15	30	45	60	60	90	120	150	90	135	180	225	180	240	300	360	225	300	375	450	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
F/ 6	8	15	23	30	25	38	50	63	35	53	70	88	68	90	113	135	83	110	138	165	160	200	240	280	220	275	330	385

SCREEN(M)	200				400				600				800				1000				1500				2000			
MINUTES	5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35
STABILITY	155mm HOWITZER																											
A/ 5	10	20	30	40	35	53	70	88	50	75	100	125	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	10	20	30	40	35	53	70	88	55	83	110	138	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	10	20	30	40	35	53	70	88	55	83	110	138	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	10	20	30	40	40	60	80	100	60	90	120	150	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
E/ 8	4	6	9	11	11	16	21	26	16	24	31	39	31	41	51	61	39	51	64	76	72	90	107	125	92	115	137	160
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	19	24	29	34	21	26	31	36	29	34	39	44	42	50	57	65

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 8D. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

VOLUME OF FIRE TABLE - WP SMOKESCREEN; RELATIVE HUMIDITY >60%

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	105mm HOWITZER																			
A/ 5	45	90	135	180	90	180	270	360	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	60	120	180	240	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
C/10	45	90	135	180	75	150	225	300	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
D/15	30	60	90	120	45	90	135	180	60	120	180	240	180	270	360	450	$$$	$$$	$$$	$$$
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280	180	270	360	450	$$$	$$$	$$$	$$$

SCREEN (M)	100				200				300				400				600			
MINUTES	5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
STABILITY	155mm HOWITZER																			
A/ 5	15	30	45	60	30	60	90	120	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$	$$$
B/ 8	8	15	23	30	15	30	45	60	23	45	68	90	60	90	120	150	$$$	$$$	$$$	$$$
C/10	8	15	23	30	15	30	45	60	15	30	45	60	45	68	90	113	60	90	120	150
D/15	15	30	45	60	8	15	23	30	15	30	45	60	30	45	60	75	45	68	90	113
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80	50	75	100	125	$$$	$$$	$$$	$$$

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF SCREENING SMOKE

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APPENDIX A

KWIK ALGORITHM
GLOSSARY OF MNEMONICS (BASIC/HP 9830A)

1.	C0	Ceiling - feet
2.	C1	Cloud cover - percent
3.	V0	Visibility - miles
4.	T0	Temperature - degrees Fahrenheit
5.	T1	Dewpoint - degrees Fahrenheit
6.	D0	Wind direction - degrees
7.	S0, S3	Windspeed - knots, meters per second
8.	P0	Atmospheric stability category
9.	H3	Slant range to target - kilometers
10.	R0	Relative humidity - percent
11.	X0	Smoke screen length - meters
12.	T2	Smoke screen duration - minutes
13.	S	Angle of sight to target - degrees
14.	A0	Direction of line of sight - degrees
15.	Y	Average roughness element - centimeters
16.	Z	Roughness length - centimeters
17.	P(7,9)	Table of stability categories depending upon solar altitude and windspeed
18.	T(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19.	C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20.	B(4)	Absorption coefficient error function
21.	G(4)	Scale height for Mie scattering
22.	H(4)	Haze and fog attenuation coefficients
23.	R(4)	Precipitation attenuation coefficients
24.	D(2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid, and far infrared wavelengths
25.	A (6)	Coefficients to compute sigma y
26.	S(6,3), D(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27.	Y1, Y2	Yield factors for HC and WP
28.	L0,L1,Z0,J0,H0	Latitude, longitude, altitude, Julian date and Zulu time data
29.	J(4,2),P(4,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30.	E(4,2), F(4,2) G(4,2), Q(4,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31.	R1, R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32.	H(2,2)	Unit (per gun) source strength

33.	Q(2)	Munition efficiency for 105- and 155-mm howitzers for HC smoke
34.	U(2,2)	WP volume source sigmas (σ_{yo} and σ_{zo}) for 105- and 155-mm howitzers
35.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
36.	W(6)	Constant (K) related to stability category for WP
37.	X(4)	Wavelength threshold levels
38.	I(4,2), Y(4,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
39.	Z(4,2), L(4,2)	Shell spacing for 105- and 155-mm howitzers for WP smoke
40.	I$(4)	Met site identifier
41.	Q$(6)	Stability category indicator
42.	A$(8)	Wavelength indicator
43.	P	Precipitation indicator
44.	H$(1), J$(1)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
45.	I	Index for wavelength algorithms
46.	J	Index for smoke algorithms
47.	K	Index for gun (105- and 155-mm howitzers) algorithms

APPENDIX B

BASIC/HP9830A ALGORITHM

```
10 COM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK SMOKE ALGORITHM - FILE 0                                (09/14/81).
30 REM KWIK: METEOROLOGICAL INPUTS AND METEOROLOGICAL CALCULATIONS.
40 DIM I$[4],P[7,9],Q$[6],H$[1],J$[1]
50 FIXED 2
60 PRINT
70 PRINT
80 PRINT "                                  MUNITION EXPENDITURES"
90 PRINT "                                   FOR HC AND WP SMOKE"
100 PRINT
110 PRINT
120 DISP "MET SITE ID";
130 INPUT I$
140 DISP "LATITUDE OF MET SITE- dEG";
150 INPUT LO
160 DISP "DIRECTION FROM EQUATOR- N OR S";
170 INPUT H$
180 DISP "LONGITUDE OF MET SITE - DEG";
190 INPUT L1
200 DISP "DIRECTION FROM GREENWICH- E OR W";
210 INPUT J$
220 DISP "ALTITUDE OF MET SITE-KILOMETERS";
230 INPUT ZO
240 DISP "JULIAN DATE OF MET OBSERVATION";
250 INPUT JO
260 DISP "ZULU TIME OF MET OBSERVATION-hr";
270 INPUT HO
280 DISP "CEILING - FEET";
290 INPUT CO
300 CO=CO*0.3048
310 DISP "CLOUD COVER - PERCENT";
320 INPUT C1
330 DISP "VISIBILITY - MILES";
340 INPUT VO
350 VO=VO*1.61
360 DISP "PRECIPITATION - 1=YES O=NO";
370 INPUT P
380 DISP "TEMPERATURE - DEG F";
390 INPUT TO
400 TO=(5/9)*(TO-32)
410 DISP "DEW POINT - DEG F";
420 INPUT T1
430 T1=(5/9)*(T1-32)
440 DISP "WIND DIRECTION - DEGS";
450 INPUT DO
460 DISP "WIND SPEED KNOTS";
470 INPUT SO
480 DISP "AVE ROUGHNESS ELEMENT - CM";
490 INPUT Y
500 PRINT "                    ID                                  = ";I$
510 PRINT "                    LATITUDE              - DEG         = ";H$[1];LO
520 PRINT "                    LONGITUDE             - DEG         = ";J$[1];L1
530 PRINT "                    ALTITUDE              - KM          = ";ZO
540 PRINT "                    JULIAN DATE           - DAY         = ";JO
550 PRINT "                    ZULU TIME             - HOUR        = ";HO
```

```
560 PRINT "                         CEILING                  - METERS     = ";C0
570 PRINT "                         CLOUD COVER              - PERCENT    = ";C1
580 PRINT "                         VISIBILITY               - KILOMETERS = ";V0
590 PRINT "                         PRECIPITATION                         = ";P
600 PRINT "                         TEMPERATURE              - DEG C      = ";T0
610 PRINT "                         DEWPOINT                 - DEG C      = ";T1
620 PRINT "                         WIND DIRECTION           - DEG        = ";D0
630 PRINT "                         WIND SPEED               - KNOTS      = ";S0
640 PRINT "                         AVE ROUGHNESS ELEMENT    - CM         = ";Y
650 FOR J=1 TO 9
660 FOR I=1 TO 7
670 READ P[I,J]
680 NEXT I
690 NEXT J
700 READ Q$[1]
710 IF J$#"E" THEN 740
720 L1=-L1
730 REM MET CALCULATIONS.
740 IF C1<100 THEN 790
750 IF C0>2133.6042 THEN 790
760 I1=0
770 I2=0
780 GOTO 1400
790 REM CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE (A0)
800 R9=PI/180
810 D9=180/PI
820 L0=L0*R9
830 A0=((J0-1)*360)/365.242
840 REM CALCULATE SOLAR DECLINATION ANGLE (A4).
850 A1=A0*R9
860 A2=279.9348+A0
870 A2=A2+(1.914827*SIN(A1))-(0.079525*COS(A1))
880 A2=A2+(0.019938*SIN(2*A1))-(0.00162*COS(2*A1))
890 A2=A2*R9
900 A3=23.4438*R9
910 A4=SIN(A3)*SIN(A2)
920 A4=ATN(A4/SQR(1-A4*A4+1E-99))
930 REM CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
940 A5=12+(0.12357*SIN(A1))-(0.004289*COS(A1))
950 A5=A5+(0.153809*SIN(2*A1))+(0.060783*COS(2*A1))
960 REM CALCULATE SOLAR HOUR ANGLE (A6)
970 A6=15*(H0-A5)-L1
980 A6=A6*R9
990 REM CALCULATE SOLAR ALTITUDE (A7)
1000 A7=SIN(L0)*SIN(A4)+COS(L0)*COS(A4)*COS(A6)
1010 A7=ATN(A7/SQR(1-A7*A7+1E-99))
1020 A7=A7*D9
1030 REM CALCULATE INSOLATION CLASS NUMBER.
1040 I2=0
1050 IF A7 <= 60 THEN 1080
1060 I2=4
1070 GOTO 1160
1080 IF A7 <= 35 THEN 1110
1090 I2=3
1100 GOTO 1160
1110 IF A7 <= 15 THEN 1140
```

```
1120 I2=2
1130 GOTO 1160
1140 IF A7 <= 0 THEN 1350
1150 I2=1
1160 REM CALCULATE NET RADIATION INDEX FOR DAYTIME.
1170 I3=0
1180 IF C1>50 THEN 1210
1190 I3=I2
1200 GOTO 1290
1210 IF CO >= 2133.6042 THEN 1240
1220 I3=I2-2
1230 GOTO 1290
1240 IF CO >= 4876.8096 THEN 1270
1250 I3=I2-1
1260 GOTO 1290
1270 IF C1#100 THEN 1290
1280 I3=I2-1
1290 IF I3#0 THEN 1310
1300 I3=I2
1310 IF I3>1 THEN 1330
1320 I3=1
1330 I1=I3
1340 GOTO 1400
1350 REM CALCULATE NET RADIATON INDEX FOR NIGHTTIME
1360 IF C1>40 THEN 1390
1370 I1=-2
1380 GOTO 1400
1390 I1=-1
1400 REM CALCULATE PASQUILL STABILITY CATEGORY.
1410 I4=0
1420 I5=0
1430 IF I1#4 THEN 1450
1440 I4=1
1450 IF I1#3 THEN 1470
1460 I4=2
1470 IF I1#2 THEN 1490
1480 I4=3
1490 IF I1#1 THEN 1510
1500 I4=4
1510 IF I1#0 THEN 1530
1520 I4=5
1530 IF I1#-1 THEN 1550
1540 I4=6
1550 IF I1#-2 THEN 1570
1560 I4=7
1570 IF SO >= 2 THEN 1600
1580 I5=1
1590 GOTO 1820
1600 IF SO >= 4 THEN 1630
1610 I5=2
1620 GOTO 1820
1630 IF SO >= 6 THEN 1660
1640 I5=3
1650 GOTO 1820
1660 IF SO >= 7 THEN 1690
1670 I5=4
```

```
1680 GOTO 1820
1690 IF SO >= 8 THEN 1720
1700 I5=5
1710 GOTO 1820
1720 IF SO >= 10 THEN 1750
1730 I5=6
1740 GOTO 1820
1750 IF SO >= 11 THEN 1780
1760 I5=7
1770 GOTO 1820
1780 IF SO >= 12 THEN 1810
1790 I5=8
1800 GOTO 1820
1810 I5=9
1820 PO=P[I4,I5]
1830 REM CALCULATE RELATIVE HUMIDITY
1840 IF TO>0 THEN 1880
1850 AO=9.5
1860 BO=265.5
1870 GOTO 1900
1880 AO=7.5
1890 BO=237.3
1900 IF T1>0 THEN 1940
1910 A1=9.5
1920 B1=265.5
1930 GOTO 1960
1940 A1=7.5
1950 B1=237.3
1960 EO=6.11*10^((AO*TO)/(BO+TO))
1970 E1=6.11*10^((A1*T1)/(B1+T1))
1980 RO=(E1/EO)*100
1990 PRINT "                PASQUILL STABILITY CATEGORY          =  ";Q$[PO,PO]
2000 PRINT "                RELATIVE HUMIDITY                    =  ";RO
2010 PRINT
2020 PRINT
2030 DISP "DONE - LINK 1"
2040 REM PASQUILL STABILITY CATEGORY DATA
2050 DATA 1,1,2,3,4,6,6
2060 DATA 1,2,2,3,4,6,6
2070 DATA 1,2,3,4,4,5,6
2080 DATA 2,2,3,4,4,5,6
2090 DATA 2,2,3,4,4,4,5
2100 DATA 2,3,3,4,4,4,5
2110 DATA 3,3,4,4,4,4,5
2120 DATA 3,3,4,4,4,4,4
2130 DATA 3,4,4,4,4,4,4
2140 DATA "ABCDEF"
2150 END
```

```
10 COM P,Y,D0,P0,R0,S0,T1,T2,V0,X0,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK:  ATMOSPHERIC OPTICS AND SMOKE CONCENTRATION CALCULATIONS (FILE 1).
30 DIM B[4],G[4],H[4],R[4],D[2],X[4]
40 FIXED 2
50 FOR I=1 TO 4
60 READ B[I],G[I],X[I]
70 NEXT I
80 V1=LOG(V0)
90 V2=V1*V1
100 V3=V2*V1
110 H[1]=1.5551-(0.9811*V1)-(0.0197*V2)+(0.0041*V3)
120 H[1]=EXP(H[1])
130 H[2]=1.50381511-(0.992319519*V1)-(0.015972801*V2)+(0.00368583*V3)
140 H[2]=EXP(H[2])
150 H[3]=1.2394-(1.0436*V1)+(0.0099*V2)-(0.0016*V3)
160 H[3]=EXP(H[3])
170 H[4]=1.5176-(1.7147*V1)+(0.0001*V2)+(0.0428*V3)
180 H[4]=EXP(H[4])
190 R[1]=1.3306-(0.8825*V1)-(0.0753*V2)+(0.0129*V3)
200 R[1]=EXP(R[1])
210 R[2]=1.481951707-(0.922595829*V1)-(0.065509417*V2)+(0.013680422*V3)
220 R[2]=EXP(R[2])
230 R[3]=1.5556-(0.9013*V1)-(0.0773*V2)+(0.0173*V3)
240 R[3]=EXP(R[3])
250 R[4]=1.5928-(0.9396*V1)-(0.0627*V2)+(0.0168*V3)
260 R[4]=EXP(R[4])
270 H0=0
280 DISP "SLANT RANGE TO TARGET - KM";
290 INPUT H3
300 DISP "ANGLE OF SIGHT TO TARGET - DEG";
310 INPUT S
320 IF S >= 0 THEN 340
330 S=-S
340 S=S*(PI/180)
350 S=SIN(S)
360 H4=0
370 IF S=0 THEN 400
380 H4=1/S
390 REM CALCULATE PRECIPITABLE WATER.
400 W=0.4477+(0.0328*T1)+(1.2E-03*T1*T1)+(1.84E-05*T1*T1*T1)
410 REM CALCULATE AMOUNT OF WATER IN PATH.
420 DEF FNA(A)=EXP(-S*A/2)
430 L0=H3
440 L1=H0
450 L2=L0
460 L3=0.5*(L1+L2)
470 L4=L2-L1
480 L5=0.2886751*L4
490 W0=0.5*L4*(FNA(L3+L5)+FNA(L3-L5))
500 W1=W*W0
510 REM CALCULATE TRANSMITTANCES FOR VISUAL,NEAR,MID AND FAR IR WAVELENGTHS.
520 FOR I=1 TO 4
530 REM CALCULATE TRANSMITTANCES OWING TO ABSORPTION BY WATER VAPOR.
540 IF I<4 THEN 570
550 T[I,1]=EXP(-0.0681*W1)
```

```
560 GOTO 670
570 DEF FNB(B)=EXP(-B^2)
580 L0=(B[I]*SQR(M1*PI)/2)
590 L1=H0
600 L2=L0
610 L3=0.5*(L1+L2)
620 L4=L2-L1
630 L5=0.2886751*L4
640 M2=0.5*L4*(FNB(L3+L5)+FNB(L3-L5))
650 T[I,1]=(2/SQR(PI))*M2
660 T[I,1]=1-T[I,1]
670 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
680 IF P=0 THEN 710
690 T[I,2]=1
700 GOTO 990
710 IF V0 >= G[I] THEN 910
720 DEF FNC(C)=EXP(C*S*LOG(0.1/H[I]))
730 L0=H4
740 L1=H0
750 L2=L0
760 L3=0.5*(L1+L2)
770 L4=L2-L1
780 L5=0.2886751*L4
790 T3=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
800 T4=EXP(-H[I]*T3)
810 DEF FND(D)=EXP(-D*S/4.1)
820 L1=H4
830 L2=H3
840 L3=0.5*(L1+L2)
850 L4=L2-L1
860 L5=0.2886751*L4
870 T5=0.5*L4*(FND(L3+L5)+FND(L3-L5))
880 T6=EXP(-0.128*T5)
890 T[I,2]=T4*T6
900 GOTO 990
910 L0=H3
920 L1=H0
930 L2=L0
940 L3=0.5*(L1+L2)
950 L4=L2-L1
960 L5=0.2886751*L4
970 T7=0.5*L4*(FND(L3+L5)+FND(L3-L5))
980 T[I,2]=EXP(-H[I]*T7)
990 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
1000 IF P=1 THEN 1030
1010 T[I,3]=1
1020 GOTO 1050
1030 IF V0>20 THEN 1010
1040 T[I,3]=EXP(-H3*R[I])
1050 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
1060 T[I,4]=X[I]/(T[I,1]*T[I,2]*T[I,3])
1070 IF T[I,4] <= 1 THEN 1090
1080 T[I,4]=1
1090 REM CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
1100 FOR K=1 TO 2
1110 READ D[K]
```

```
1120 NEXT K
1130 IF T[I,4]#1 THEN 1180
1140 FOR J=1 TO 2
1150 C[I,J]=0
1160 NEXT J
1170 GOTO 1240
1180 FOR K=1 TO 2
1190 IF D[K]#0 THEN 1220
1200 C[I,K]=0
1210 GOTO 1230
1220 C[I,K]=LOG(T[I,4])/-D[K]
1230 NEXT K
1240 NEXT I
1250 DISP "DONE - LINK 2"
1260 DATA 0.118,26.7,0.05
1270 DATA 0.18,7.5,0.05
1280 DATA 0.55,5.1,0.05
1290 DATA 0,5,0.05
1300 DATA 3.3,2.46
1310 DATA 1.5,2
1320 DATA 0,0.25
1330 DATA 0,0.32
1340 END
```

```
10 DIM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK: ATMOSPHERIC DIFFUSION CALCULATIONS                (FILE2)
30 DIM S[6,3],A[6],Q[2],H[2,2],D[6,3],U[2,2]
40 FIXED 2
50 DISP "DIRECTION OF LINE OF SIGHT-DEG";
60 INPUT AO
70 REM ATMOSPHERIC DIFFUSION CALCULATIONS.
80 FOR I=1 TO 6
90 READ A[I]
100 NEXT I
110 FOR I=1 TO 6
120 FOR J=1 TO 3
130 READ S[I,J]
140 NEXT J
150 NEXT I
160 FOR I=1 TO 6
170 FOR J=1 TO 3
180 READ D[I,J]
190 NEXT J
200 NEXT I
210 READ H[1,1],H[1,2],H[2,1],H[2,2]
220 READ U[1,1],U[2,1],U[1,2],U[2,2]
230 A1=-1.24+1.19*LGT(Y)
240 Z=10^A1
250 A2=ABS(AO-DO)*(PI/180)
260 R2=SQR(13.69/(13.69*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
270 Y1=1.09521547+(0.02906894*RO)-(4.9575E-04*RO*RO)+(4.82E-06*RO*RO*RO)
280 Y2=3.364059144+(0.060502571*RO)-(1.15301E-03*RO*RO)+(1.33942E-05*RO*RO*RO)
290 C2=S[PO,1]+S[PO,2]*Z+S[PO,3]*Z^2
300 D1=D[PO,1]+D[PO,2]*Z+D[PO,3]*Z^2
310 D2=1/D1
320 IF SO#0 THEN 340
330 SO=1
340 S3=0.515*SO
350 DISP "SCREEN LENGTH - METERS";
360 INPUT XO
370 DISP "DURATION - MINUTES";
380 INPUT T2
390 FOR N=1 TO 6
400 READ W[N]
410 NEXT N
420 FOR I=1 TO 4
430 REM CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
440 FOR K=1 TO 2
450 IF I<3 AND PO>4 THEN 490
460 S1=U[K,1]+0.74*A[PO]*100^0.9
470 S2=U[K,2]+0.667*C2*100^D1
480 V[K]=(W[PO]*Y2*H[K,2])/(PI*S1*S2)
490 REM MUNITION EXPENDITURES (HC SMOKE).
500 REM MUNITION EFFICIENCY:
510 Q[1]=0.4
520 Q[2]=0.4
530 REM SUSTAINING SHELL SPACING FOR HC SMOKE.
540 IF I>2 THEN 610
550 IF C[I,1]#0 THEN 580
```

```
560 Y[I,K]=0
570 GOTO 610
580 Y[I,K]=1/R2*(0.731*Q[K]*Y1*H[K,1]/(C2*S3*C[I,1]))^D2
590 IF Y[I,K]<X0 THEN 610
600 Y[I,K]=X0
610 NEXT K
620 NEXT I
630 DISP "DONE - LINK 3"
640 REM DATA USED TO CALCULATE SIGMA Y FOR CONTIUOUS SOURCE.
650 DATA 0.4,0.32,0.22,0.144,0.102,0.076
660 REM DATA USED TO CALCULATE SIGMA Z FOR CONTINUOUS SOURCE.
670 DATA 0.139085297,0.015017284,-1.02581E-04
680 DATA 0.122097643,0.01097037,-6.80135E-05
690 DATA 0.110104377,0.010962963,-6.73401E-05
700 DATA 0.097649832,0.010418519,-6.83502E-05
710 DATA 0.070772166,7.27284E-03,-4.50056E-05
720 DATA 0.055487093,6.55309E-03,-4.01796E-05
730 DATA 0.944814815,-4.85185E-03,3.7037E-05
740 DATA 0.894803591,-4.83951E-03,3.59147E-05
750 DATA 0.854792368,-4.82716E-03,3.47924E-05
760 DATA 0.816026936,-6.07407E-03,4.7138E-05
770 DATA 0.786026936,-6.07407E-03,4.7138E-05
780 DATA 0.726015713,-6.06173E-03,4.60157E-05
790 REM UNIT (PER GUN) SOURCE STRENGTHS.
800 DATA 18.7,1737.3,77.1,7076.2
810 REM WP VOLUME SOURCE SIGMAS (U(2,2)).
820 DATA 5.4,7.9,1.8,2.6
830 REM STABILITY CONSTANTS FOR WP SMOKE.
```

```
10 COM N,Y,D0,P0,R0,S0,T1,T2,V0,X0,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK:  MUNITION EXPENDITURES (CONTINUATION)                (FILE 3).
30 DIM R[4,2],I[4,2],J[4,2],P[4,2],E[4,2],F[4,2],G[4,2],H[2,2],Q[4,2],L[4,2]
40 DIM A$[8]
50 FIXED 2
60 S3=D0*0.515
70 REM UNIT SOURCE STRENGTH.
80 READ H[1,1],H[1,2],H[2,1],H[2,2]
90 FOR I=1 TO 4
100 FOR K=1 TO 2
110 IF I>2 THEN 430
120 REM CALCULATE INITIAL SHELL SPACING FOR HC SMOKE.
130 I[I,K]=S3*45
140 IF Y[I,K]#0 THEN 180
150 E[I,K]=1
160 F[I,K]=1
170 GOTO 330
180 REM CALCULATE INITIAL VOLLEY FOR HC SMOKE.
190 IF I[I,K]>Y[I,K] THEN 210
200 GOTO 220
210 I[I,K]=Y[I,K]
220 E[I,K]=X0/I[I,K]
230 Q5=INT(E[I,K])
240 Q6=E[I,K]-Q5
250 IF Q6=0 THEN 270
260 E[I,K]=Q5+1
270 REM CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC SMOKE).
280 F[I,K]=X0/Y[I,K]
290 Q5=INT(F[I,K])
300 Q6=F[I,K]-Q5
310 IF Q6=0 THEN 330
320 F[I,K]=Q5+1
330 REM CALCULATE RATE OF FIRE FOR HC SMOKE.
340 R1=0.5
350 IF C[I,1]#0 THEN 370
360 R1=0
370 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE).
380 J[I,K]=E[I,K]+(R1*T2-1)*F[I,K]
390 Q5=INT(J[I,K])
400 Q6=J[I,K]-Q5
410 IF Q6=0 THEN 430
420 J[I,K]=Q5+1
430 IF I<3 AND P0>4 THEN 950
440 REM SHELL SPACING <L( ) & Z( )> & VOLLEYS <G( ) & Q( )> - WP SMOKE.
450 IF C[I,2]#0 THEN 500
460 Z[I,K]=0
470 G[I,K]=0
480 Q[I,K]=0
490 GOTO 630
500 IF I>2 THEN 550
510 L[I,K]=V[K]/C[I,2]*100
520 Z[I,K]=L[I,K]
530 G[I,K]=X0/Z[I,K]
540 GOTO 560
550 G[I,K]=0.6*C[I,2]/V[K]
```

```
560 Q5=INT(G[I,K])
570 Q6=G[I,K]-Q5
580 IF Q6=0 THEN 610
590 G[I,K]=Q5+1
600 GOTO 620
610 G[I,K]=Q5
620 Q[I,K]=G[I,K]
630 REM RATE OF FIRE FOR WP SMOKE.
640 IF C[I,2]#0 THEN 680
650 R[I,K]=0
660 GOTO 820
670 IF I>2 THEN 700
680 R[I,K]=(Z[I,K]+60)/S3
690 GOTO 710
700 R[I,K]=120/S3
710 R[I,K]=R[I,K]/20
720 R5=INT(R[I,K])
730 R6=R[I,K]-R5
740 IF R6<0.5 THEN 760
750 R5=R5+1
760 IF R5#0 THEN 780
770 R5=1
780 R[I,K]=R5*20/60
790 R[I,K]=1/R[I,K]
800 IF R[I,K] >= 1 THEN 820
810 R[I,K]=1
820 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP SMOKE).
830 IF C[I,2]#0 THEN 860
840 P[I,K]=0
850 GOTO 1030
860 IF I>2 THEN 890
870 P[I,K]=G[I,K]+Q[I,K]*(T2*R[I,K]-1)
880 GOTO 900
890 P[I,K]=Q[I,K]*(X0/60+1)*(T2*R[I,K]-1)
900 Q5=INT(P[I,K])
910 Q6=P[I,K]-Q5
920 IF Q6=0 THEN 940
930 P[I,K]=Q5+1
940 GOTO 1290
950 REM CALCULATIONS FOR WP SMOKE E & F STABILITY CATEGORIES (STABLE FLOW).
960 REM INITIAL SHELL SPACING
970 IF I=1 AND K=1 THEN 1000
980 IF I<3 AND K=2 THEN 1000
990 IF I=2 AND K=1 THEN 1020
1000 L[I,K]=100
1010 GOTO 1030
1020 L[I,K]=50
1030 REM SUSTAINING SHELL SPACING
1040 IF I=1 AND K=1 THEN 1080
1050 IF I=2 AND K=2 THEN 1080
1060 IF I=1 AND K=2 THEN 1100
1070 IF I=2 AND K=1 THEN 1120
1080 Z[I,K]=100
1090 GOTO 1130
1100 Z[I,K]=200
1110 GOTO 1130
```

```
1120 Z[I,K]=50
1130 REM INITIAL VOLLEY - WP SMOKE.
1140 G[I,K]=X0/L[I,K]+1
1150 REM SUSTAINING VOLLEY.
1160 Q[I,K]=X0/Z[I,K]+1
1170 REM RATE OF FIRE - WP SMOKE.
1180 IF K=1 THEN 1200
1190 IF K=2 THEN 1220
1200 R[I,K]=2
1210 GOTO 1230
1220 R[I,K]=1
1230 REM TOTAL NUMBER OF WP ROUNDS REQUIRED.
1240 P[I,K]=G[I,K]+Q[I,K]*(T2*R[I,K]-1)
1250 Q5=INT(P[I,K])
1260 Q6=P[I,K]-Q5
1270 IF Q6=0 THEN 1290
1280 P[I,K]=Q5+1
1290 NEXT K
1300 NEXT I
1310 FOR I=1 TO 4
1320 PRINT
1330 PRINT
1340 PRINT
1350 PRINT
1360 PRINT
1370 PRINT
1380 READ A$
1390 PRINT "                                        ";A$
1400 PRINT
1410 PRINT
1420 PRINT "                                                            METERS MINUTES"
1430 WRITE (15,1440)X0,T2
1440 FORMAT "                      SCREEN LENGTH/DURATION: ",F5.0,4X,F3.0
1450 PRINT
1460 PRINT
1470 IF I>2 THEN 1980
1480 PRINT "                                        HC SMOKE SCREEN"
1490 PRINT
1500 PRINT
1510 PRINT "                                        105MM HOWITZER"
1520 PRINT
1530 PRINT "                      VOLLEY        GUNS RATE/ SPACING ROUNDS"
1540 PRINT "                                         MIN    METERS"
1550 WRITE (15,1560)E[I,1],I[I,1]
1560 FORMAT "                      INITIAL:     ",F5.0,6X,F8.0
1570 WRITE (15,1580)F[I,1],R1,Y[I,1],J[I,1]
1580 FORMAT "                      SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1590 PRINT
1600 PRINT
1610 PRINT
1620 PRINT "                                        155MM HOWITZER"
1630 PRINT
1640 PRINT "                      VOLLEY        GUNS RATE/ SPACING ROUNDS"
1650 PRINT "                                         MIN    METERS"
1660 WRITE (15,1670)E[I,2],I[I,2]
1670 FORMAT "                      INITIAL:     ",F5.0,6X,F8.0
```

```
1680 WRITE (15,1690)F[I,2],R1,Y[I,2],J[I,2]
1690 FORMAT "                         SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1700 PRINT
1710 PRINT
1720 PRINT
1730 PRINT "                                      WP SMOKE SCREEN"
1740 PRINT
1750 PRINT
1760 PRINT "                                      105MM HOWITZER"
1770 PRINT
1780 PRINT "                        VOLLEY        GUNS RATE/ SPACING ROUNDS"
1790 PRINT "                                            MIN   METERS"
1800 WRITE (15,1810)G[I,1],L[I,1]
1810 FORMAT "                         INITIAL:    ",F5.0,6X,F8.0
1820 WRITE (15,1830)Q[I,1],R[I,1],Z[I,1],P[I,1]
1830 FORMAT "                         SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1840 PRINT
1850 PRINT
1860 PRINT
1870 PRINT "                                      155MM HOWITZER"
1880 PRINT
1890 PRINT "                        VOLLEY        GUNS RATE/ SPACING ROUNDS"
1900 PRINT "                                            MIN   METERS"
1910 WRITE (15,1920)G[I,2],L[I,2]
1920 FORMAT "                         INITIAL:    ",F5.0,6X,F8.0
1930 WRITE (15,1940)Q[I,2],R[I,2],Z[I,2],P[I,2]
1940 FORMAT "                         SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1950 PRINT
1960 PRINT
1970 IF I<3 THEN 2070
1980 PRINT "                                      WP SMOKE SCREEN"
1990 PRINT
2000 PRINT
2010 PRINT "                                   ROUNDS/   RATE/   TOTAL"
2020 PRINT "                                  60 METERS  MINUTE  ROUNDS"
2030 WRITE (15,2040)Q[I,1],R[I,1],P[I,1]
2040 FORMAT "                          105MM:  ",F5.0,5X,F3.0,5X,F7.0
2050 WRITE (15,2060)Q[I,2],R[I,2],P[I,2]
2060 FORMAT "                          155MM:  ",F5.0,5X,F3.0,5X,F7.0
2070 NEXT I
2080 PRINT
2090 PRINT
2100 PRINT
2110 PRINT
2120 PRINT
2130 PRINT
2140 DISP "DONE"
2150 REM UNIT (PER GUN) SOURCE STRENGTHS.
2160 DATA 18.7,1737.3,77.1,7076.2
2170 DATA "VISIBLE:"
2180 DATA "NEAR IR:"
2190 DATA "MID IR:"
2200 DATA "FAR IR:"
2210 END
```

APPENDIX C

KWIK ALGORITHM (PRINTER)

GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1.	A	Ceiling - meters
2.	B	Cloud cover - percent
3.	C	Visibility - kilometers
4.	D	Temperature - degrees Celsius
5.	E	Dewpoint - degrees Celsius
6.	F	Wind direction - degrees
7.	G	Windspeed - knots
8.	H	Atmospheric stability category
9.	O	Slant range to target - kilometers
10.	Q	Relative humidity - percent
11.	R	Smoke screen length - meters
12.	T	Smoke screen duration - minutes
13.	U	Angle of sight to target - degrees
14.	V	Direction of line of sight - degrees
15.	Y	Average roughness element - centimeters
16.	Z	Roughness length - centimeters
17.	A(7,9)	Table of stability categories depending upon solar altitude and windspeed
18.	B(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19.	C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20.	D(4)	Absorption coefficient error function
21.	E(4)	Scale height for Mie scattering
22.	F(4)	Haze and fog attenuation coefficients
23.	G(4)	Precipitation attenuation coefficients
24.	H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25.	I(7)	Graphics scaling factors
26.	J(6)	Coefficients to compute sigma y
27.	K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
28.	M(2)	Yield factors for HC and WP
29.	N(5)	Latitude, longitude, altitude, Julian date and Zulu time data
30.	O(3)	Graphics translator files
31.	P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
32.	Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzer, for HC and WP smokes (by wavelengths)

33.	P, R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
34.	S(2,2)	Unit (per gun) source strength
35.	T(2)	Munition efficiency for 105- and 155-mm howitzer, for HC smoke
36.	U(2,2)	WP volume source sigmas (σ_{yo} and σ_{zo}) for 105- and 155-mm howitzer
37.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
38.	W(6)	Constant (K) related to stability category for WP smoke
39.	X(4)	Wavelength threshold levels
40.	Y(4,2,2)	Shell spacing for 105- and 155-mm howitzer (initial and sustaining) for HC smoke
41.	Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
42.	A$(4)	Met site identifier
43.	B$(6)	Stability category indicator
44.	C$(4,8)	Wavelength indicator
45.	D$(3)	Precipitation indicator
46.	E$(2,2)	HC or WP smoke indicator
47.	G$(1)	105-mm howitzer indicator
48.	G$(2)	155-mm howitzer indicator
49.	E$(2)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
50.	I	Index for wavelength algorithms
51.	J	Index for smoke algorithms
52.	K	Index for gun (105- and 155-mm howitzer) algorithms

APPENDIX D

PRINTER (HPL/HP9825A) ALGORITHM

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0: "KWIK SMOKE PROGRAM - PAPER TAPE VERSION (08/20/80)":
1: dim A[7,9],D[4],E[4],H[2,4],J[6],K[6,3],L[6,3]
2: dim B[4,4],C[4,2],F[4],G[4],I[7],M[2],N[5]
3: dim O[6],P[4,2,2],Q[4,2,2,2],R[4,2],S[2,2]
4: dim T[2],U[2,2],V[2],W[6],X[4],Y[4,2,2],Z[4,2,2]
5: dim A$[4],B$[6],C$[4,8],D$[3],E$[2],F$[2,2],G$[2,5],H$[2]
6: "INITIALIZATION":
7: idt 1,A[*],D[*],E[*],H[*],J[*],K[*],L[*]
8: "  UNIT SOURCE STRENGTHS":
9: 18.7→S[1,1];1737.3→S[1,2];77.1→S[2,1];7076.2→S[2,2]
10: .4→T[1]→T[2]
11: 5.4→U[1,1];7.9→U[2,1];1.8→U[1,2];2.6→U[2,2]
12: .016→W[1]→W[2]→W[3]→W[4]→W[5]→W[6]
13: "  WAVELENGTH THRESHOLD LEVELS":
14: .05→X[1]→X[2]→X[3]→X[4]
15: "  PASQUILL STABILITY CATEGORY INDICATOR":
16: "ABCDEF"→B$
17: "  WAVELENGTH INDICATOR":
18: "VISIBLE:"→C$[1];"NEAR IR:"→C$[2];"MID IR:  "→C$[3];"FAR IR: "→C$[4]
19: "  LATITUDE/LONGITUDE DEFAULT DIRECTIONS":
20: "NW"→E$
21: "  SMOKE TYPES":
22: "HC"→F$[1];"WP"→F$[2]
23: "  SMOKE DELIVERY SYSTEM NAMES":
24: "105MM"→G$[1];"155MM"→G$[2]
25: "MET SITE INFORMATION":
26: ent "MET SITE ID",A$
27: cap(A$)→A$
28: ent "LATITUDE OF MET SITE - DEG",N[1]
29: "DIRECTION FROM EQUATOR - N OR S":
30: "N"→E$[1,1]
31: cap(E$[1,1])→E$[1,1]
32: ent "LONGITUDE OF MET SITE - DEG",N[2]
33: ent "DIRECTION FROM GREENWICH- E OR W",E$[2,2]
34: cap(E$[2,2])→E$[2,2]
35: if E$[2,2]="E";-N[2]→N[2]
36: ent "ALTITUDE OF MET SITE - KM",N[3]
37: ent "JULIAN DATE OF MET OBSERVATION",N[4]
38: ent "ZULU TIME OF MET OBSERVATION",N[5]
39: "MET INPUTS":
40: ent "CEILING - METERS",A
41: ent "CLOUD COVER - PERCENT",B
42: ent "VISIBILITY - KM",C
43: ent "PRECIPITATION - YES OR NO",D$
44: cap(D$)→D$
45: ent "TEMPERATURE - DEG C",D
46: ent "DEW POINT - DEG C",E
47: ent "WIND DIRECTION - DEG",F
48: ent "WIND SPEED - KNOTS",G
49: ent "AVERAGE ROUGHNESS ELEMENT - CM",Y
50: ent "SLANT RANGE TO TARGET - KM",O
*21332
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51: ent "ANGLE OF SIGHT TO TARGET - DEG",U
52: if U<0;-U→U
53: sin(U)→U
54: ent "DIRECTION OF LINE OF SIGHT - DEG",V
55: ent "LENGTH OF SMOKE SCREEN - METERS",R
56: ent "DURATION OF SMOKE SCREEN - MIN",T
57: "MET CALCULATIONS":
58: if B#100;gto "K1000"
59: if A>2133.6042;gto "K1000"
60: 0→r0
61: 0→r1
62: gto "K1400"
63: "K1000":
64: "CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE":
65: (N[4]-1)*360/365.242→r9
66: "CALCULATE SOLAR DECLINATION ANGLE":
67: 279.9348+r9→r11
68: r11+1.914827*sin(r9)-.079525*cos(r9)→r11
69: r11+.019938*sin(2*r9)-.00162*cos(2*r9)→r11
70: 23.4438→r12
71: sin(r12)*sin(r11)→r13
72: asn(r13)→r13
73: "CALCULATE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON":
74: 12+.12357*sin(r9)-.004289*cos(r9)→r14
75: r14+.153809*sin(2*r9)+.060783*cos(2*r9)→r14
76: "CALCULATE SOLAR HOUR ANGLE":
77: 15*(N[5]-r14)-N[2]→r15
78: "CALCULATE SOLAR ALTITUDE":
79: sin(N[1])*sin(r13)+cos(N[1])*cos(r13)*cos(r15)→r16
80: asn(r16)→r16
81: "CALCULATE INSOLATION CLASS NUMBER":
82: 0→r1
83: if r16>60;4→r1;gto "K1100"
84: if r16>35;3→r1;gto "K1100"
85: if r16>15;2→r1;gto "K1100"
86: if r16<=0;gto "K1300"
87: 1→r1
88: "K1100":
89: "CALCULATE NET RADIATION INDEX FOR DAYTIME":
90: 0→r2
91: if B<=50;r1→r2;gto "K1200"
92: if A<2133.6042;r1-2→r2;gto "K1200"
93: if A<4876.8096;r1-1→r2;gto "K1200"
94: if B=100;r1-1→r2
95: "K1200":
96: if r2=0;r1→r2
97: if r2<1;1→r2
98: r2→r0;gto "K1400"
99: "K1300":
100: "CALCULATE NET RADIATION INDEX FOR NIGHTTIME":
101: if B<40;-2→r0;gto "K1400"
*16402
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102: -1→r0
103: "K1400":
104: "CALCULATE PASQUILL STABILITY CATEGORY":
105: 0→r4;0→r5
106: if r0=4;1→r4
107: if r0=3;2→r4
108: if r0=2;3→r4
109: if r0=1;4→r4
110: if r0=0;5→r4
111: if r0=-1;6→r4
112: if r0=-2;7→r4
113: if G<2;1→r5;gto "K1500"
114: if G<4;2→r5;gto "K1500"
115: if G<6;3→r5;gto "K1500"
116: if G<7;4→r5;gto "K1500"
117: if G<8;5→r5;gto "K1500"
118: if G<10;6→r5;gto "K1500"
119: if G<11;7→r5;gto "K1500"
120: if G<12;8→r5;gto "K1500"
121: 9→r5
122: "K1500":
123: A[r4,r5]→H
124: "CALCULATE RELATIVE HUMIDITY":
125: if D>0;gto "K1600"
126: 9.5→r0;265.5→r1
127: gto "K1700"
128: "K1600":
129: 7.5→r0;237.3→r1
130: "K1700":
131: if E>0;gto "K1800"
132: 9.5→r2;265.5→r3
133: gto "K1900"
134: "K1800":
135: 7.5→r2;237.3→r3
136: "K1900":
137: 6.11*10^(r0*D/(r1+D))→r4
138: 6.11*10^(r2*E/(r3+E))→r5
139: r5/r4*100→Q
140: fxd 2
141: prt " "
142: prt " "
143: prt "    MUNITION"
144: prt "  EXPENDITURES"
145: prt "      FOR"
146: prt "   HC AND WP"
147: prt "     SMOKE"
148: prt " "
149: prt " "
150: prt "ID      = "&A$
151: prt "LAT     = "&E$[1,1]&str(N[1])
152: prt "LONG    = "&E$[2,2]&str(abs(N[2]))
*10090
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153: prt "ALT     ="&str(N[3])
154: prt "DATE    ="&str(N[4])
155: prt "TIME    ="&str(N[5])
156: prt "CEIL    ="&str(A)
157: prt "SKY     ="&str(B)
158: prt "VIS     ="&str(C)
159: prt "PRECIP = "&D$
160: prt "TEMP    ="&str(D)
161: prt "TD      ="&str(E)
162: prt "WD      ="&str(F)
163: prt "WS      ="&str(G)
164: prt "ARE     ="&str(Y)
165: prt "PSC     = "&B$[H,H]
166: prt "RH      ="&str(Q)
167: prt " "
168: prt " "
169: "ATMOSPHERIC OPTICS CALCULATIONS":
170: ln(C)→r0
171: r0*r0→r1
172: r1*r0→r2
173: 1.5551-.9811*r0-.0197*r1+.0041*r2→F[1]
174: exp(F[1])→F[1]
175: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2→F[2]
176: exp(F[2])→F[2]
177: 1.2394-1.0436*r0+.0099*r1-.0016*r2→F[3]
178: exp(F[3])→F[3]
179: 1.5176-1.7147*r0+.0001*r1+.0428*r2→F[4]
180: exp(F[4])→F[4]
181: 1.3306-.8825*r0-.0753*r1+.0129*r2→G[1]
182: exp(G[1])→G[1]
183: 1.481951707-.92255589*r0-.065509417*r1+.013680422*r2→G[2]
184: exp(G[2])→G[2]
185: 1.5556-.9613*r0-.0773*r1+.0173*r2→G[3]
186: exp(G[3])→G[3]
187: 1.5928-.9396*r0-.0627*r1+.0168*r2→G[4]
188: exp(G[4])→G[4]
189: 0→r8
190: if U#0;1/U→r8
191: "CALCULATE PRECIPITABLE WATER":
192: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3→r11
193: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
194: 0→r0;U→r1;r0→r2;.5*(r1+r2)→r3
195: r2-r1→r4;.2886751*r4→r5
196: .5*r4*('FNA'(r3+r5)+'FNA'(r3-r5))→r9
197: r11*r9→r10
198: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
199: for I=1 to 4
200: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY WATER VAPOR.":
201: if I=4;exp(-.0681*r10)→U[I,1];gto "k2600"
202: D[I]*√(r10*π)/2→r0;0→r1;r0→r2
203: .5*(r1+r2)→r3
*12715
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204: r2-r1→r4
205: .2886751*r4→r5
206: .5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r12
207: 2/√π*r12→B[I,1]
208: 1-B[I,1]→B[I,1]
209: "K2600":
210: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.":
211: if D$="YES";1→B[I,2];gto "K2900"
212: if C>=E[I];gto "K2800"
213: r6→r0;0→r1;r0→r2
214: .5*(r1+r2)→r3
215: r2-r1→r4
216: .2886751*r4→r5
217: .5*r4*('FNC'(r3+r5)+'FNC'(r3-r5))→r13
218: exp(-F[I]*r13)→r14
219: U-r6→r0;r8→r1;r8+r0→r2
220: .5*(r1+r2)→r3
221: r2-r1→r4
222: .2886751*r4→r5
223: .5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r15
224: exp(-.128*r15)→r16
225: r14*r16→B[I,2];gto "K2900"
226: "K2800":
227: 0→r0;0→r1;r0→r2;.5*(r1+r2)→r3
228: r2-r1→r4;.2886751*r4→r5
229: .5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r17
230: exp(-F[I]*r17)→B[I,2]
231: "K2900":
232: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION":
233: if D$="NO";1→B[I,3];gto "K3100"
234: if C>20;1→B[I,3];gto "K3100"
235: exp(-U*G[I])→B[I,3]
236: "K3100":
237: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.":
238: K[I]/(B[I,1]*B[I,2]*B[I,3])→B[I,4]
239: if B[I,4]>1;1→B[I,4]
240: "CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.":
241: if B[I,4]#0;gto "K3400"
242: for J=1 to 2;0→C[I,J]
243: next J;gto "K3475"
244: "K3400":
245: for J=1 to 2
246: if H[J,I]=0;0→C[I,J];gto "K3450"
247: ln(B[I,4])/-H[J,I]→C[I,J]
248: "K3450":
249: next J
250: "K3475":
251: next I
252: "ATMOSPHERIC DIFFUSION CALCULATIONS":
253: 10^(-1.24+1.19*log(Y))→Z
254: abs(V-F)→r8
*16460
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255: √(13.69/(13.69*sin(r8)*sin(r8)+cos(r8)*cos(r8)))→r15
256: 1.09521547+.02906694*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q→M[1]
257: 3.364059144+.000502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q→M[2]
258: K[H,1]+K[H,2]*Z+K[H,3]*Z^2→r9
259: L[H,1]+L[H,2]*Z+L[H,3]*Z^2→r10
260: 1/r10→r11
261: if C=0;1→C
262: .515*C→r16
263: for I=1 to 4
264: "CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE":
265: for K=1 to 2
266: if I<3;if H>4;gto "K3500"
267: U[K,1]+.74*J[H]*100^.9→r4
268: U[K,2]+.667*r9*100^r10→r5
269: W[H]*M[2]*S[K,2]/(π*r4*r5)→V[K]
270: "K3500":
271: "MUNITTION EXPENDITURE CALCULATIONS":
272: if I>2;gto "K4100"
273: "CALCULATE INITIAL SHELL SPACING FOR HC SMOKE":
274: r16*45→Y[I,1,K]
275: "CALCULATE SUSTAINING SHELL SPACING FOR HC SMOKE":
276: if C[I,1]#0;gto "K3600"
277: 0→Y[I,2,K];gto "K3700"
278: "K3600":
279: 1/r15*(.731*T[K]*M[1]*S[K,1]/(C[I,1]*r16*r9))^r11→Y[I,2,K]
280: if Y[I,2,K]>R;R→Y[I,2,K]
281: "K3700":
282: if Y[I,2,K]=0;1→Q[I,1,K,1]→Q[I,2,K,1];gto "K4000"
283: "CALCULATE INITIAL VOLLEY FOR HC SMOKE":
284: if Y[I,1,K]>Y[I,2,K];Y[I,2,K]→Y[I,1,K]
285: R/Y[I,1,K]→Q[I,1,K,1]
286: if frc(Q[I,1,K,1])>0;int(Q[I,1,K,1])+1→Q[I,1,K,1]
287: "CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)":
288: R/Y[I,2,K]→Q[I,2,K,1]
289: if frc(Q[I,2,K,1])>0;int(Q[I,2,K,1])+1→Q[I,2,K,1]
290: "K4000":
291: "RATE OF FIRE FOR HC SMOKE":
292: .5→P;if C[I,1]=0;0→P
293: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC)":
294: Q[I,1,K,1]+Q[I,2,K,1]*(P*T-1)→P[I,K,1]
295: if frc(P[I,K,1])>0;int(P[I,K,1])+1→P[I,K,1]
296: "K4100":
297: if I<3;if H>4;gto "K4300"
298: "SHELL SPACING (Z[ ]) & VOLLEYS (Q[ ]) - WP":
299: if C[I,2]#0;gto "K4120"
300: 0→Z[I,1,K]→Z[I,2,K]
301: 0→Q[I,1,K,2]→Q[I,2,K,2]
302: gto "K4180"
303: "K4120":
304: if I>2;.6*C[I,2]/V[K]→Q[I,1,K,2];gto "K4140"
305: V[K]/C[I,2]*100→Z[I,1,K]
*2556
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306: Z[I,1,K]+Z[I,2,K]
307: R/Z[I,2,K]+Q[I,1,K,2]
308: "K4140":
309: int(Q[I,1,K,2])+r1
310: if frc(Q[I,1,K,2])>0;r1+1+r1
311: r1+Q[I,1,K,2]+Q[I,2,K,2]
312: "K4180":
313: "RATE OF FIRE FOR WP SMOKE":
314: if C[I,2]=0;0+R[I,K];gto "K4200"
315: if I>2;120/r16+R[I,K];gto "K4190"
316: (Z[I,2,K]+60)/r16+R[I,K]
317: "K4190":
318: R[I,K]/20+R[I,K]
319: int(R[I,K])+r0
320: if frc(R[I,K])>=.5;int(R[I,K])+1+r0
321: if r0=0;1+r0
322: r0*20/60+R[I,K]
323: 1/R[I,K]+R[I,K]
324: if R[I,K]<1;1+R[I,K]
325: "K4200":
326: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP)":
327: if C[I,2]=0;0+P[I,K,2];gto "K4500"
328: Q[I,1,K,2]+Q[I,2,K,2]*(T*R[I,K]-1)+P[I,K,2]
329: if I>2;Q[I,2,K,2]*(R/60+1)*(T*R[I,K]-1)+P[I,K,2]
330: if frc(P[I,K,2])>0;int(P[I,K,2])+1+P[I,K,2]
331: gto "K4500"
332: "K4300":
333: "CALCULATIONS FOR WP E & F STABILITY CATEGORIES":
334: "INITIAL SHELL SPACING - WP SMOKE":
335: if I=1;if K=1;100+Z[I,1,K]
336: if I=2;if K=1;50+Z[I,1,K]
337: if I<3;if K=2;100+Z[I,1,K]
338: "SUSTAINING SHELL SPACING - WP SMOKE":
339: if I=1;if K=1;100+Z[I,2,K]
340: if I=1;if K=2;200+Z[I,2,K]
341: if I=2;if K=1;50+Z[I,2,K]
342: if I=2;if K=2;100+Z[I,2,K]
343: "INITIAL VOLLEY - WP SMOKE":
344: R/Z[I,1,K]+1+Q[I,1,K,2]
345: "SUSTAINING VOLLEY - WP SMOKE":
346: R/Z[I,2,K]+1+Q[I,2,K,2]
347: "RATE OF FIRE - WP SMOKE":
348: if K=1;2+R[I,K]
349: if K=2;1+R[I,K]
350: "TOTAL NUMBER OF WP ROUNDS REQUIRED":
351: Q[I,1,K,2]+Q[I,2,K,2]*(T*R[I,K]-1)+P[I,K,2]
352: "K4500":
353: next K
354: next I
355: fxd 0
356: for I=1 to 4
*7502
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357: prt " "
358: prt " "
359: prt "****************"
360: prt "     "&C$[I]
361: prt " "
362: prt " "
363: prt "SCREEN"
364: prt "  LENGTH:  "&str(int(R))
365: prt "  DURATION:"&str(int(T))
366: for J=1 to 2
367: if J=1;if I>2;gto "FIRST K"
368: prt " "
369: prt " "
370: prt F$[J]&" SMOKE SCREEN"
371: "FIRST K":
372: for K=1 to 2
373: if J=1;if I>2;gto "NEXT K"
374: if I>2;gto "M&F IR"
375: prt " "
376: prt " "
377: prt "      "&G$[K]
378: prt " "
379: prt "VOLLEY"
380: prt " "
381: prt "INTIAL:    "
382: prt "         GUNS"
383: prt "         "&str(Q[I,1,K,J])
384: prt " "
385: prt "         SPACING"
386: prt "          METERS"
387: if J=1;prt "          "&str(Y[I,1,K])
388: if J=2;prt "          "&str(Z[I,1,K])
389: prt " "
390: prt "SUSTAINING:"
391: prt "         GUNS"
392: prt "         "&str(Q[I,2,K,J])
393: prt " "
394: fxd 1
395: prt "         RATE/"
396: prt "          MIN"
397: if J=1;prt "        "&str(P)
398: if J=2;prt "        "&str(R[I,K])
399: prt " "
400: fxd 0
401: prt "         SPACING"
402: prt "          METERS"
403: if J=1;prt "          "&str(Y[I,2,K])
404: if J=2;prt "          "&str(Z[I,2,K])
405: prt " "
406: prt "         ROUNDS"
407: prt "         "&str(P[I,K,J])
*18000
```

```
408: prt " "
409: if I<3;gto "NEXT K"
410: "M&F IR":
411: prt " "
412: prt " "
413: prt G$[K]&":"
414: prt "          ROUNDS/"
415: prt "          60 METERS"
416: prt "          "&str(Q[I,2,K,J])
417: prt " "
418: fxd 1
419: prt "          RATE/"
420: prt "          MINUTE"
421: prt "          "&str(R[I,K])
422: prt " "
423: fxd 0
424: prt "          TOTAL"
425: prt "          ROUNDS"
426: prt "          "&str(P[I,K,J])
427: prt " "
428: "NEXT K":
429: next K
430: next J
431: next I
432: prt " "
433: prt " "
434: dsp "DONE"
435: end
436: "FUNCTIONS":
437: "FNA":ret exp(-U*pl/2)
438: "FNB":ret exp(-pl^2)
439: "FNC":ret exp(pl*U*ln(.1/F[I]))
440: "FND":ret exp(-pl*U/4.1)
*32707
```

APPENDIX E

CRT KWIK ALGORITHM
GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1.	A	Ceiling - feet
2.	B	Cloud cover - percent
3.	C	Visibility - miles
4.	D	Temperature - degrees Fahrenheit
5.	E	Dewpoint - degrees Fahrenheit
6.	F	Wind direction - degrees
7.	G	Windspeed - knots
8.	H	Atmospheric stability category
9.	O	Slant range to target - kilometers
10.	Q	Relative humidity - percent
11.	R	Smoke screen length - meters
12.	T	Smoke screen duration - minutes
13.	U	Angle of sight to target - degrees
14.	V	Direction of line of sight degrees
15.	Y	Average roughness element - centimeters
16.	Z	Roughness length - centimeters
17.	A(7,9)	Table of stability categories depending upon solar altitude and windspeed
18.	B(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19.	C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20.	D(4)	Absorption coefficient error function
21.	E(4)	Scale height for Mie scattering
22.	F(4)	Haze and fog attenuation coefficients
23.	G(4)	Precipitation attenuation coefficients
24.	H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25.	I(7)	Graphics scaling factors
26.	J(6)	Coefficients to compute sigma y
27.	K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
28.	M(2)	Yield factors for HC and WP
29.	N(5)	Latitude, longitude, altitude, Julian date and Zulu time data
30.	O(3)	Graphics translator files
31.	P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
32.	Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP (by wavelengths)

33.	R(4,2); L, M	Rate of fire for WP smokes (by wavelengths) for 105- and 155-mm howitzers
34.	P	Rate of fire for HC smoke
35.	S(2,2)	Unit (per gun) source strength
36.	T(2)	Munition efficiency for 105-mm howitzers, for HC smoke
37.	U(2,2)	WP volume source sigmas (σ_{yo} and σ_{zo}) for 105- and 155-mm howitzers
38.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
39.	W(6)	Constant (K) related to stability category for WP smoke
40.	X(4)	Wavelength threshold levels
41.	Y(4,2,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
42.	Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
43.	A$(4)	Met site identifier
44.	B$(6)	Stability category indicator
45.	C$(32)	Wavelength indicator
46.	D$(3)	Precipitation indicator
47.	E$(2)	HC or WP smoke indicator
48.	F$(3)	105-mm howitzer indicator
49.	G$(3)	155-mm howitzer indicator
50.	H$(2,2)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
51.	I	Index for wavelength algorithms
52.	J	Index for smoke algorithms
53.	K	Index for gun (105- or 155-mm howitzers) algorithms

APPENDIX F

CRT (HPL/HP9825A) ALGORITHM

```
0: "AWIK SMOKE PROGRAM -  CRT VERSION (9/10/81)":
1: dim A[7,9],D[4],E[4],H[2,4],J[6],K[6,3],L[6,3]
2: dim B[4,4],C[4,2],F[4],G[4],I[7],M[2],N[5]
3: dim O[6],P[4,2,2],Q[4,2,2,2],R[4,2],S[2,2]
4: dim T[2],U[2,2],V[2],W[6],X[4],Y[4,2,2],Z[4,2,2]
5: dim A$[4],B$[6],C$[4,8],D$[3],E$[2],F$[3],G$[3],H$[2]
6: "INITIAL.":
7: for 1,A[*],D[*],E[*],H[*],J[*],K[*],L[*]
8: "  GRAPH. TRANS. FILE SIZES":
9: 43→O[1];905→O[2];1100→O[3]
10: "  UNIT SRC. STREN.":
11: 18.7→S[1,1];1737.3→S[1,2];77.1→S[2,1];7076.2→S[2,2]
12: "  MUN. EFF. FOR HC SMOKE":
13: .4→T[1]→T[2]
14: "  VOL. SRC. SIG. FOR WP SMOKE":
15: 5.4→U[1,1];7.9→U[2,1];1.8→U[1,2];2.6→U[2,2]
16: "  CONSTS. RELATED TO STAB. FOR WP SMK":
17: .016→W[1]→W[2]→W[3]→W[4]→W[5]→W[6]
18: "  WVL THRES LEVELS":
19: .05→X[1]→X[2]→X[3]→X[4]
20: "   STABLTY. CAT. IND.":
21: "ABCDEF"→B$
22: "  WVL INDICATOR":
23: "VISIBLE:"→C$[1];"NEAR IR:"→C$[2];"MID IR:"→C$[3];"FAR IR:"→C$[4]
24: "  SMK DLVRY SYS NAMES":
25: "105"→F$
26: "155"→G$
27: "  LAT/LONG DEFLT DRCTNS.":
28: "NW"→H$
29: "INITIAL. DISP.":
30: cll 7
31: wtb 718,3,20,13,10,"em::en::ex::sn::sx::um::"
32: fmt 1,f4.0,","
33: wrt 718,"f1 0000,"
34: for I=1 to 3
35: I-1→J
36: wrt 718.1,"n1",J
37: for K=1 to O[I]
38: wrt 718,"pe0,::pa0,0;"
39: next K
40: wrt 718,"sn"
41: next I
42: "SCL DISP":
43: 11→I[1]
44: 8.5→I[2]
45: 1022/I[1]→I[3]
46: 1023/I[2]→I[4]
47: "DSPLY0":
48: wrt 718,"ef0,::ff0,::bf0,"
49: cll 'TITLE'(0,8)
50: wtb 718,"pe1,::txMUNITION EXPENDITURES",3,13,10
*21223
```

```
51: cll 'NEXTLINE'(1.5)
52: wtb 718,"pel,::tx FOR HC AND WP SMOKE ",3,13,10
53: wrt 718,"uf0,"
54: "MET SITE INFO":
55: ent "MET SITE ID",A$
56: cap(A$)→A$
57: ent "LATITUDE OF MET SITE - DEG",N[1]
58: "DIRECTION FROM EQUATOR- N or S":
59: "N"→H$[1,1]
60: cap(H$[1,1])→H$[1,1]
61: ent "LONGITUDE OF MET SITE - DEG",N[2]
62: ent "DIRECTION FROM GREENWICH- E or W",H$[2,2]
63: cap(H$[2,2])→H$[2,2]
64: if H$[2,2]="E";-N[2]→N[2]
65: ent "ALTITUDE OF MET SITE-KILOMETERS",N[3]
66: ent "JULIAN DATE OF MET OBSERVATION",N[4]
67: ent "ZULU TIME OF MET OBSERVATION-HR",N[5]
68: "MET INPUTS":
69: ent "CEILING - FEET",A
70: A*.3048→A
71: ent "CLOUD COVER - PERCENT",B
72: ent "VISIBILITY - MILES",C
73: C*1.61→C
74: ent "PRECIPITATION - YES OR NO",D$
75: cap(D$)→D$
76: ent "TEMPERATURE - DEG F",D
77: 5/9*(D-32)→D
78: ent "DEW POINT - DEG F",E
79: 5/9*(E-32)→E
80: ent "WIND DIRECTION - DEGS",F
81: ent "WIND SPEED - KNOTS",G
82: ent "AVE ROUGHNESS ELEMENT - CM",Y
83: ent "SLANT RANGE TO TARGET - KM",O
84: ent "ANGLE OF SIGHT TO TARGET - DEG",U
85: if U<0;-U→U
86: sin(U)→U
87: ent "DIRECTION OF LINE OF SIGHT - DEG",V
88: ent "SCREEN LENGTH - METERS",R
89: ent "DURATION - MINUTES",T
90: "DSPLY1":
91: fmt 1,f6.2,1b
92: fmt 2,f7.2,1b
93: fmt 3,f3.0,1b
94: wrt 718,"bt0,::ef1,::ff1,::bf1,"
95: cll 'LINE'(0,5)
96: wtb 718,"pel,::txID                                    = ",A$,3,13,10
97: cll 'NEXTLINE'(1.5)
98: wrt 718.2,"pel,::txLATITUDE                  - DEG      = ",H$[1,1],N[1],3
99: cll 'NEXTLINE'(1.5)
100: wrt 718.2,"pel,::txLONGITUDE                - DEG      = ",H$[2,2],N[2],3
101: cll 'NEXTLINE'(1.5)
*20210
```

```
102: wrt 718.2,"pel,::txALTITUDE                  - KM       = ",N[3],3
103: cll 'NEXTLINE'(1.5)
104: wrt 718.3,"pel,::txJULIAN DATE               - DAY      = ",N[4],3
105: cll 'NEXTLINE'(1.5)
106: wrt 718.3,"pel,::txZULU TIME                 - HOUR     = ",N[5],3
107: cll 'NEXTLINE'(1.5)
108: wrt 718.2,"pel,::txCEILING                   - METERS   = ",A,3
109: cll 'NEXTLINE'(1.5)
110: wrt 718.2,"pel,::txCLOUD COVER               - PERCENT  = ",B,3
111: cll 'NEXTLINE'(1.5)
112: wrt 718.2,"pel,::txVISIBILITY                - KM       = ",C,3
113: cll 'NEXTLINE'(1.5)
114: wtb 718,"pel,::txPRECIPITATION                         = ",D$
115: wtb 718,3,13,10
116: cll 'NEXTLINE'(1.5)
117: wrt 718.2,"pel,::txTEMPERATURE               - DEG C    = ",D,3
118: cll 'NEXTLINE'(1.5)
119: wrt 718.2,"pel,::txDEWPOINT                  - DEG C    = ",E,3
120: cll 'NEXTLINE'(1.5)
121: wrt 718.2,"pel,::txWIND DIRECTION            - DEG      = ",F,3
122: cll 'NEXTLINE'(1.5)
123: wrt 718.2,"pel,::txWIND SPEED                - KNOTS    = ",G,3
124: cll 'NEXTLINE'(1.5)
125: wrt 718.2,"pel,::txAVE ROUGHNESS ELEMENT - CM       = ",Y,3
126: if H$[2,2]="E",-N[2]→N[2]
127: "MET CALC":
128: if B#100;gto "K1000"
129: if A>2133.6042;gto "K1000"
130: 0→r0
131: 0→r1
132: gto "K1400"
133: "K1000":
134: "CALC ANGL FRAC OF A YR FOR A GIVN JULN DATE":
135: (N[4]-1)*360/365.242→r9
136: "CALC SOLAR DECL ANGLE":
137: 279.9348+r9→r11
138: r11+1.914827*sin(r9)-.079525*cos(r9)→r11
139: r11+.019938*sin(2*r9)-.00162*cos(2*r9)→r11
140: 23.4438→r12
141: sin(r12)*sin(r11)→r13
142: asn(r13)→r13
143: "CALC TIME OF MERID PASS - TRUE SOLAR NOON":
144: 12+.12357*sin(r9)-.004289*cos(r9)→r14
145: r14+.153809*sin(2*r9)+.060783*cos(2*r9)→r14
146: "CALC SOLAR HR ANGLE":
147: 15*(N[5]-r14)-N[2]→r15
148: "CALC SOLAR ALT":
149: sin(N[1])*sin(r13)+cos(N[1])*cos(r13)*cos(r15)→r16
150: asn(r16)→r16
151: "CALC INSOL CLASS NUM":
152: 0→r1
*20456
```

```
if r16>60;4→r1;gto "K1100"
if r16>35;3→r1;gto "K1100"
if r16>15;2→r1;gto "K1100"
if r16<=0;gto "K1300"
1→r1
"K1100":
"CALC NET RAD INDX FOR DYTIME":
0→r2
if B<=50;r1→r2;gto "K1200"
if A<2133.6042;r1-2→r2;gto "K1200"
if A<4876.8096;r1-1→r2;gto "K1200"
if B=100;r1-1→r2
"K1200":
if r2=0;r1→r2
if r2<1;1→r2
r2→r0;gto "K1400"
"K1300":
"CALC NET RAD INDX FOR NTTIME":
if B<40;-2→r0;gto "K1400"
-1→r0
"K1400":
"CALC STABLTY CAT":
0→r4;0→r5
if r0=4;1→r4
if r0=3;2→r4
if r0=2;3→r4
if r0=1;4→r4
if r0=0;5→r4
if r0=-1;6→r4
if r0=-2;7→r4
if G<2;1→r5;gto "K1500"
if G<4;2→r5;gto "K1500"
if G<6;3→r5;gto "K1500"
if G<7;4→r5;gto "K1500"
if G<8;5→r5;gto "K1500"
if G<10;6→r5;gto "K1500"
if G<11;7→r5;gto "K1500"
if G<12;8→r5;gto "K1500"
9→r5
"K1500":
A[r4,r5]→H
"CALC REL HUMDTY":
if D>0;gto "K1600"
9.5→r0;265.5→r1
gto "K1700"
"K1600":
7.5→r0;237.3→r1
"K1700":
if E>0;gto "K1800"
9.5→r2;265.5→r3
gto "K1900"
*17300
```

```
204: "K1600":
205: 7.5→r2;237.3→r3
206: "K1900":
207: 6.11*10^(r0*D/(r1+D))→r4
208: 6.11*10^(r2*E/(r3+E))→r5
209: r5/r4*100→Q
210: cll 'NEXTLINE'(1.5)
211: wtb 718,"pel,::txPASQUILL STABILITY CATEGORY      = ",B$[H,H],3,13,10
212: cll 'NEXTLINE'(1.5)
213: wrt 718.2,"pel,::txRELATIVE HUMIDITY                   =",Q,3
214: wrt 718,"ufl,"
215: dsp "CONTINUE WHEN READY";stp
216: "ATMOSPHERIC OPTICS CALCULATIONS":
217: ln(C)→r0
218: r0*r0→r1
219: r1*r0→r2
220: 1.5551-.9811*r0-.0197*r1+.0041*r2→F[1]
221: exp(F[1])→F[1]
222: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2→F[2]
223: exp(F[2])→F[2]
224: 1.2394-1.0436*r0+.0099*r1-.0016*r2→F[3]
225: exp(F[3])→F[3]
226: 1.5176-1.7147*r0+.0001*r1+.0428*r2→F[4]
227: exp(F[4])→F[4]
228: 1.3306-.8825*r0-.0753*r1+.0129*r2→G[1]
229: exp(G[1])→G[1]
230: 1.481951707-.9225589*r0-.065509417*r1+.013680422*r2→G[2]
231: exp(G[2])→G[2]
232: 1.5556-.9013*r0-.0773*r1+.0173*r2→G[3]
233: exp(G[3])→G[3]
234: 1.5928-.9396*r0-.0627*r1+.0168*r2→G[4]
235: exp(G[4])→G[4]
236: 0→r8
237: if U#0;1/U→r8
238: "CALCULATE PRECIPITABLE WATER":
239: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3→r11
240: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
241: 0→r0;0→r1;r0→r2;.5*(r1+r2)→r3
242: r2-r1→r4;.2886751*r4→r5
243: .5*r4*('FNA'(r3+r5)+'FNA'(r3-r5))→r9
244: r11*r9→r10
245: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
246: for I=1 to 4
247: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY WATER VAPOR.":
248: if I=4;exp(-.0681*r10)→B[I,1];gto "K2600"
249: D[I]*√(r10*π)/2→r0;0→r1;r0→r2
250: .5*(r1+r2)→r3
251: r2-r1→r4
252: .2886751*r4→r5
253: .5*r4*('FNB'(r3+r5)+'FNB'(r3-r5))→r12
254: 2/√π*r12→B[I,1]
*12485
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```
1-B[I,1]→B[I,1]
"K2600":
"CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.":
if D$="YES";1→B[I,2];gto "K2900"
if C>=E[I];gto "K2800"
r8→r0;0→r1;r0→r2
.5*(r1+r2)→r3
r2-r1→r4
.2886751*r4→r5
.5*r4*('FNC'(r3+r5)+'FNC'(r3-r5))→r13
exp(-F[I]*r13)→r14
0-r8→r0;r8→r1;r8+r0→r2
.5*(r1+r2)→r3
r2-r1→r4
.2886751*r4→r5
.5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r15
exp(-.128*r15)→r16
r14*r16→B[I,2];gto "K2900"
"K2800":
0→r0;0→r1;r0→r2;.5*(r1+r2)→r3
r2-r1→r4;.2886751*r4→r5
.5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r17
exp(-F[I]*r17)→B[I,2]
"K2900":
"CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION":
if D$="NO";1→B[I,3];gto "K3100"
if C>20;1→B[I,3];gto "K3100"
exp(-U*G[I])→B[I,3]
"K3100":
"CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.":
A[I]/(B[I,1]*B[I,2]*B[I,3])→B[I,4]
if B[I,4]>1;1→B[I,4]
"CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION":
if B[I,4]#0;gto "K3400"
for J=1 to 2;0→C[I,J]
next J;gto "K3475"
"K3400":
for J=1 to 2
if H[J,1]=0;0→C[I,J];gto "K3450"
ln(B[I,4])/-H[J,1]→C[I,J]
"K3450":
next J
"K3475":
next I
"ATMOSPHERIC DIFFUSION CALCULATIONS":
10^(-1.24+1.19*log(Y))→Z
abs(V-F)→r8
√(13.69/(13.69*sin(r8)*sin(r8)+cos(r8)*cos(r8)))→r15
1.09521547+.02906894*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q→M[1]
3.364059144+.060502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q→M[2]
K[N,1]+K[N,2]*Z+K[N,3]*Z^2→r9
*26908
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306: L[H,1]+L[H,2]*Z+L[H,3]*Z^2→r10
307: 1/r10→r11
308: if G=0;1→G
309: .515*G→r10
310: for I=1 to 4
311: "CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE":
312: for K=1 to 2
313: if I<3;if H>4;gto "K3500"
314: U[K,1]+.74*J[H]*100^.9→r4
315: U[K,2]+.667*r9*100^r10→r5
316: W[H]*M[2]*S[K,2]/(π*r4*r5)→V[K]
317: "K3500":
318: "MUNITION EXPENDITURE CALCULATIONS":
319: wrt 718,"Df1,"
320: if I>2;gto "K4100"
321: "CALCULATE INITIAL SHELL SPACING FOR HC SMOKE":
322: r16*45→Y[I,1,K]
323: "SUSTAINING SHELL SPACING FOR HC SMOKE":
324: if C[I,1]#0;gto "K3600"
325: 0→Y[I,2,K];gto "K3700"
326: "K3600":
327: 1/r15*(.731*T[K]*M[1]*S[K,1]/(C[I,1]*r16*r9))^r11→Y[I,2,K]
328: if Y[I,2,K]>R;R→Y[I,2,K]
329: "K3700":
330: if Y[I,2,K]=0;1→Q[I,1,K,1]→Q[I,2,K,1];gto "K4000"
331: "CALCULATE INITIAL VOLLEY FOR HC SMOKE":
332: if Y[I,1,K]>Y[I,2,K];Y[I,2,K]→Y[I,1,K]
333: R/Y[I,1,K]→Q[I,1,K,1]
334: if frc(Q[I,1,K,1])>0;int(Q[I,1,K,1])+1→Q[I,1,K,1]
335: "CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)":
336: R/Y[I,2,K]→Q[I,2,K,1]
337: if frc(Q[I,2,K,1])>0;int(Q[I,2,K,1])+1→Q[I,2,K,1]
338: "K4000":
339: "RATE OF FIRE FOR HC SMOKE":
340: .5→P;if C[I,1]=0;0→P
341: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC)":
342: Q[I,1,K,1]+Q[I,2,K,1]*(P*T-1)→P[I,K,1]
343: if frc(P[I,K,1])>0;int(P[I,K,1])+1→P[I,K,1]
344: "K4100":
345: if I<3;if H>4;gto "K4300"
346: "SHELL SPACING (Z[ ]) & VOLLEYS (Q[ ]) - WP SMOKE":
347: if C[I,2]#0;gto "K4120"
348: 0→Z[I,1,K]→Z[I,2,K]
349: 0→Q[I,1,K,2]→Q[I,2,K,2]
350: gto "K4160"
351: "K4120":
352: if I>2;.6*C[I,2]/V[K]→Q[I,1,K,2];gto "K4140"
353: V[K]/C[I,2]*100→Z[I,1,K]
354: Z[I,1,K]→Z[I,2,K]
355: R/Z[I,2,K]→Q[I,1,K,2]
356: "K4140":
*23032
```

```
int(Q[I,1,K,2])→r1
if frc(Q[I,1,K,2])>0;r1+1→r1
r1→Q[I,1,K,2]→Q[I,2,K,2]
"K4180":
"RATE OF FIRE FOR WP SMOKE":
if C[I,2]=0;0→R[I,K];gto "K4200"
if I>2;120/r16→R[I,K];gto "K4190"
(Z[I,2,K]+60)/r16→R[I,K]
"K4190":
R[I,K]/20→R[I,K]
int(R[I,K])→r0
if frc(R[I,K])>=.5;int(R[I,K])+1→r0
if r0=0;1→r0
r0*20/60→R[I,K]
1/R[I,K]→R[I,K]
if R[I,K]<1;1→R[I,K]
"K4200":
"CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP)":
if C[I,2]=0;0→P[I,K,2];gto "K4500"
Q[I,1,K,2]+Q[I,2,K,2]*(T*R[I,K]-1)→P[I,K,2]
if I>2;Q[I,2,K,2]*(K/60+1)*(T*R[I,K]-1)→P[I,K,2]
if frc(P[I,K,2])>0;int(P[I,K,2])+1→P[I,K,2]
gto "K4500"
"K4300":
"CALCULATIONS FOR WP STABLE FLOW (E AND F STABILITY CATEGORIES)":
"INITIAL SHELL SPACING FOR WP SMOKE":
if I=1;if K=1;100→Z[I,1,K]
if I=2;if K=1;50→Z[I,1,K]
if I<3;if K=2;100→Z[I,1,K]
"SUSTAINING SHELL SPACING FOR WP SMOKE":
if I=1;if K=1;100→Z[I,2,K]
if I=1;if K=2;200→Z[I,2,K]
if I=2;if K=1;50→Z[I,2,K]
if I=2;if K=2;100→Z[I,2,K]
"INITIAL VOLLEY FOR WP SMOKE":
R/Z[I,1,K]+1→Q[I,1,K,2]
"SUSTAINING VOLLEY FOR WP SMOKE":
R/Z[I,2,K]+1→Q[I,2,K,2]
"RATE OF FIRE FOR WP SMOKE":
if K=1;2→R[I,K]
if K=2;1→R[I,K]
"CALCULATE TOTAL NUMBER OF WP ROUNDS REQUIRED":
Q[I,1,K,2]+Q[I,2,K,2]*(T*R[I,K]-1)→P[I,K,2]
"K4500":
R[I,1]→L
R[I,2]→M
next K
"DISPLAY2":
fmt 4,f5.0,4x,f3.0,15
fmt 5,f5.0,6x,f8.0,15
fmt 6,f5.0,f5.1,f9.0,f7.0,15
*21524
```

```
408: fmt 7,f5.0,5x,f3.0,5x,f5.0,1b
409: "HC"→E$;if I>2;"WP"→E$
410: cll 'HEADING'
411: if I>2;cll 'MIR/FIR';gto "K5000"
412: cll 'GUN1'(1,1,P,Y[I,1,1],Y[I,2,1])
413: cll 'GUN2'(2,1,P,Y[I,1,2],Y[I,2,2])
414: wrt 718,"uf2,"
415: dsp "CONTINUE WHEN READY";stp
416: "WP"→E$
417: cll 'HEADING'
418: cll 'GUN1'(1,2,R[I,1],Z[I,1,1],Z[I,2,1])
419: cll 'GUN2'(2,2,R[I,2],Z[I,1,2],Z[I,2,2])
420: "K5000":
421: wrt 718,"uf2,"
422: dsp "CONTINUE WHEN READY";stp
423: next I
424: wrt 718,"bf2,"
425: ent "0 TO EXIT - 1 TO PRINT",w
426: if w=0;gto "K7000"
427: gsb "PRINTER 0"
428: for I=1 to 4
429: cll 'PRINTER 1'
430: if I>2;cll 'PRINTER 3';gto "K6000"
431: "HC"→E$
432: cll 'PRINTER 2'(1,P,P,Y[I,1,1],Y[I,2,1],Y[I,1,2],Y[I,2,2])
433: "WP"→E$
434: cll 'PRINTER 2'(2,L,M,Z[I,1,1],Z[I,2,1],Z[I,1,2],Z[I,2,2])
435: fmt 5/;wrt 701
436: "K6000":
437: next I
438: "K7000":
439: dsp "DONE"
440: end
441: "FUNCTIONS":
442: "FNA":ret exp(-U*p1/2)
443: "FNB":ret exp(-p1^2)
444: "FNC":ret exp(p1*U*ln(.1/F[1]))
445: "FND":ret exp(-p1*U/4.1)
446: "SUBROUTINES":
447: "XPOS":ret I[4]*p1*I[5]
448: "YPOS":ret I[4]*(I[2]-I[5]*p1)
449: "YPOS1":ret I[7]-p1*I[4]*I[5]
450: "TITLE":
451: .5→I[5]
452: 'XPOS'(p1)→I[6]
453: 'YPOS'(p2)→I[7]
454: fmt 1,f4.0,",",f4.0,";"
455: wrt 718.1,"cs2,::pe0,::pa",I[6],I[7]
456: ret
457: "LINE":
458: .25→I[5]
*29007
```

```
459: 'XPOS'(p1)→r[6]
460: 'YPOS'(p2)→r[7]
461: fmt 1,f4.0,",",f4.0,";"
462: wrt 718.1,"csl,::pe0,::pa",r[6],r[7]
463: ret
464: "NEXTLINE":
465: 'YPOS1'(p1)→r[7]
466: fmt 1,f4.0,",",f4.0,";"
467: wrt 718.1,"pe0,::pa",r[6],r[7]
468: ret
469: "HEADING":
470: wrt 718,"ef2,::ff2,::bf2,"
471: cll 'LINE'(2,4)
472: wtb 718,"pel,::tx                    ",C$[1],3,13,10
473: cll 'NEXTLINE'(2)
474: wtb 718,"pel,::tx                                   METERS MINUTES",3,13,10
475: cll 'NEXTLINE'(1.5)
476: wrt 718.4,"pel,::txSCREEN LENGTH/DURATION:",R,T,3
477: cll 'NEXTLINE'(4)
478: wtb 718,"pel,::tx                    ",E$," SMOKE SCREEN",3,13,10
479: ret
480: "GUN1":
481: cll 'NEXTLINE'(3)
482: wtb 718,"pel,::tx                    ",F$,"MM HOWITZER",3,13,10
483: cll 'NEXTLINE'(3)
484: wtb 718,"pel,::txVOLLEY       GUNS RATE/ SPACING ROUNDS",3,13,10
485: cll 'NEXTLINE'(1.25)
486: wtb 718,"pel,::tx                         MIN   METERS        ",3,13,10
487: cll 'NEXTLINE'(1.5)
488: wrt 718.5,"pel,::txINITIAL:    ",Q[1,1,p1,p2],p4,3
489: cll 'NEXTLINE'(1.25)
490: if E$="WP";if H>4;2→p3
491: wrt 718.6,"pel,::txSUSTAINING:",Q[1,2,p1,p2],p3,p5,P[1,p1,p2],3
492: ret
493: "GUN2":
494: cll 'NEXTLINE'(3)
495: wtb 718,"pel,::tx                    ",G$,"MM HOWITZER",3,13,10
496: cll 'NEXTLINE'(3)
497: wtb 718,"pel,::txVOLLEY       GUNS RATE/ SPACING ROUNDS",3,13,10
498: cll 'NEXTLINE'(1.25)
499: wtb 718,"pel,::tx                         MIN   METERS        ",3,13,10
500: cll 'NEXTLINE'(1.5)
501: wrt 718.5,"pel,::txINITIAL:    ",Q[1,1,p1,p2],p4,3
502: cll 'NEXTLINE'(1.25)
503: if E$="WP";if H>4;1→p3
504: wrt 718.6,"pel,::txSUSTAINING:",Q[1,2,p1,p2],p3,p5,P[1,p1,p2],3
505: ret
506: "MIN/FIR":
507: cll 'NEXTLINE'(3)
508: wtb 718,"pel,::tx            ROUNDS/    RATE/    TOTAL",3,13,10
509: cll 'NEXTLINE'(1.125)
*27790
```

```
510: wtb 718,"pcl,::tx       60 METERS  MINUTE  ROUNDS",3,13,10
511: cll 'NEXTLINE'(1.25)
512: wrt 718.7,"pcl,::tx",F$,"MM:  ",Q[1,2,1,2],R[1,1],P[1,1,2],3
513: cll 'NEXTLINE'(1.25)
514: wrt 718.7,"pcl,::tx",G$,"MM:  ",Q[1,2,2,2],R[1,2],P[1,2,2],3
515: ret
516: "PRINTER 0":
517: fmt 21/;wrt 701
518: fmt 55x,"MUNITION EXPENDITURES";wrt 701
519: fmt 56x,"FOR HC AND WP SMOKE";wrt 701
520: fmt 2/;wrt 701
521: fmt 45x,"ID                                    = ",c4;wrt 701,A$
522: fmt 45x,"LATITUDE                   - DEG      = ",c1,f6.2
523: wrt 701,H$[1,1],N[1]
524: if N[2]<0;N[2]*-1+N[2]
525: fmt 45x,"LONGITUDE                  - DEG      = ",c1,f6.2
526: wrt 701,H$[2,2],N[2]
527: fmt 45x,"ALTITUDE                   - KM       = ",f7.2;wrt 701,N[3]
528: fmt 45x,"JULIAN DATE                - DAY      = ",f4.0;wrt 701,N[4]
529: fmt 45x,"ZULU TIME                  - HOUR     = ",f4.0;wrt 701,N[5]
530: fmt 45x,"CEILING                    - METERS   = ",f7.2;wrt 701,A
531: fmt 45x,"CLOUD COVER                - PERCENT  = ",f7.2;wrt 701,B
532: fmt 45x,"VISIBILITY                 - KM       = ",f7.2;wrt 701,C
533: fmt 45x,"PRECIPITATION                         = ",c3;wrt 701,D$
534: fmt 45x,"TEMPERATURE                - DEG C    = ",f7.2;wrt 701,D
535: fmt 45x,"DEW POINT                  - DEG C    = ",f7.2;wrt 701,E
536: fmt 45x,"WIND DIRECTION             - DEG      = ",f7.2;wrt 701,F
537: fmt 45x,"WIND SPEED                 - KNOTS    = ",f7.2;wrt 701,G
538: fmt 45x,"AVE ROUGHNESS ELEMENT      - CM       = ",f7.2;wrt 701,Y
539: fmt 45x,"PASQUILL STABILITY CATEGORY           = ",c1;wrt 701,B$[H,H]
540: fmt 45x,"RELATIVE HUMIDITY                     = ",f7.2;wrt 701,Q
541: fmt 21/;wrt 701
542: ret
543: "PRINTER 1":
544: fmt 4/;wrt 701
545: fmt 62x,c8;wrt 701,C$[1]
546: fmt 3/;wrt 701
547: fmt 47x,"                        METERS MINUTES";wrt 701
548: fmt 47x,"SCREEN LENGTH/DURATION:",f5.0,4x,f3.0;wrt 701,R,T
549: ret
550: "PRINTER 2":
551: fmt 2/;wrt 701
552: fmt 59x,c2," SMOKE SCREEN";wrt 701,E$
553: fmt 2/;wrt 701
554: fmt 59x,c3,"MM HOWITZER";wrt 701,F$
555: fmt /;wrt 701
556: fmt 47x,"VOLLEY      GUNS RATE/ SPACING ROUNDS";wrt 701
557: fmt 47x,"                MIN   METERS";wrt 701
558: fmt 47x,"INITIAL:   ",f5.0,6x,f8.0;wrt 701,Q[1,1,1,p1],p4
559: fmt 47x,"SUSTAINING:",f5.0,f5.1,f9.0,f7.0
560: if E$="WP";if H>4;2+p2
*24008
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```
561: wrt 701,Q[1,2,1,p1],p2,p5,P[I,1,p1]
562: fmt 2/;wrt 701
563: fmt 59x,c3,"MM HOWITZER";wrt 701,G$
564: fmt /;wrt 701
565: fmt 47x,"VOLLEY      GUNS RATE/ SPACING ROUNDS";wrt 701
566: fmt 47x,"                     MIN   METERS";wrt 701
567: fmt 47x,"INITIAL:    ",f5.0,6x,f8.0;wrt 701,Q[1,1,2,p1],p6
568: fmt 47x,"SUSTAINING:",f5.0,f5.1,f9.0,f7.0
569: if E$="WP";if H>4;1→p3
570: wrt 701,Q[1,2,2,p1],p3,p7,P[1,2,p1]
571: ret
572: "PRINTER 3":
573: fmt 2/;wrt 701
574: fmt 59x,c2," SMOKE SCREEN";wrt 701,E$
575: fmt 2/;wrt 701
576: fmt 47x,"         ROUNDS/   RATE/   TOTAL";wrt 701
577: fmt 47x,"       60 METERS  MINUTE  ROUNDS";wrt 701
578: fmt 47x,c3,"MM:  ",f5.0,5x,f3.1,5x,f5.0
579: wrt 701,F$,Q[1,2,1,2],R[1,1],P[I,1,2]
580: fmt 47x,c3,"MM:  ",f5.0,5x,f3.1,5x,f5.0
581: wrt 701,G$,Q[I,2,2,2],R[1,2],P[1,2,2]
582: fmt 42/;wrt 701
583: ret
*19077
```

APPENDIX G

KWIK ALGORITHM
GLOSSARY OF MNEMONICS (FORTRAN IV)

1.	CO	Ceiling - feet
2.	C1	Cloud cover - percent
3.	VO	Visibility - miles
4.	TO	Temperature - degrees Fahrenheit
5.	TI	Dewpoint - degrees Fahrenheit
6.	DO	Wind direction - degrees
7.	SO	Windspeed - knots
8.	PO	Atmospheric stability category
9.	H3	Slant range to target - kilometers
10.	RO	Relative humidity - percent
11.	XO	Smoke screen length - meters
12.	TIME	Smoke screen duration - minutes
13.	AST	Angle of sight to target - degrees
14.	DLS	Direction of line of sight - degrees
15.	ARE	Average roughness element - centimeters
16.	Z1	Roughness element - centimeters
17.	PSCTAB	Table of stability categories depending upon solar altitude and windspeed
18.	T(4,4)	Table of transmittances resulting from water vapor, haze/fog, precipitation and smoke for visual, near, mid, and far infrared wavelengths
19.	C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20.	B(4)	Absorption coefficient error function
21.	E(4)	Scale height for Mie scattering
22.	F(4)	Haze and fog attenuation coefficients
23.	G(4)	Precipitation attenuation coefficients
24.	CS(4,2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25.	A(6)	Coefficients to compute sigma y
26.	S(6,3),D(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27.	Y1, Y2	Yield factors for HC and WP
28.	SLAT, SLONG SALT, SJDATE, SJHOUR	Latitude, longitude, altitude, Julian date and Zulu time data
29.	P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30.	R1, Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31.	R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32.	H(2,2)	Unit (per gun) source strength

33.	ME(2)	Munition efficiency for 105- and 155-mm howitzer for HC smoke
34.	U(2,2)	WP volume source sigma (σ_{yo} and σ_{zo}) for 105- and 155-mm howitzer
35.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
36.	W(6)	Constant (K) related to stability category for WP smoke
37.	X(4)	Wavelength threshold levels
38.	Y(4,2,2)	Shell spacing for 105- and 155-mm howitzer (initial and sustaining) for HC smoke
39.	Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
40.	SITE	Met site identifier
41.	PSC(6)	Stability category indicator
42.	WLNGTH(4,2)	Wavelength indicator
43.	PRECIP	Precipitation indicator
44.	SMOKE(2)	HC or WP smoke indicator
45.	GUN(1)	105-mm howitzer indicator
46.	GUN(2)	155-mm howitzer indicator
47.	DFE, DFG	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
48.	I	Index for wavelength algorithms
49.	J	Index for smoke algorithms
50.	K	Index for gun (105- and 155-mm howitzer) algorithms

APPENDIX H

FORTRAN IV ALGORITHM

```
      BLOCK DATA
      INTEGER PO
      COMMON /KWIK/ PRECIP,ARE,C0,C1,C2,D0,D2,P0,R0,R2,S0,S3,T0,T1,
     2             Y1,VC,H3,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
     3             U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOUR,DFE,DFG
      CHARACTER*8 WLNGTH
      COMMON /OUTPUT/ WLNGTH(4),SMOKE(2),GUN(2),PSC(6),R1,
     2                   R(4,2),Q(4,2,2,2),P(4,2,2)
      DATA ((H(I,J),J=1,2),I=1,2)/19.7,1737.3,77.1,7075.2/
      DATA U/5.4,7.9,1.9,2.5/
      DATA WLNGTH /8HVISIBLE:,8HNEAR IR:,8HMID IR: ,8HFAR IR: /
      DATA SMOKE /2HHC,2HWP/
      DATA GUN /3H105,3H155/
      DATA PSC(1)/4HA   /,PSC(2)/4HB   /
      DATA PSC(3)/4HC   /,PSC(4)/4HD   /
      DATA PSC(5)/4HE   /,PSC(6)/4HF   /
      END
C*KWIK SMOKE PROGRAM.
      INTEGER PO
      COMMON /KWIK/ PRECIP,ARE,C0,C1,C2,D0,D2,P0,R0,R2,S0,S3,T0,T1,
     2             Y1,VC,H3,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
     3             U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOUR,DFE,DFG
C*METEOROLOGICAL INPUTS.
      READ(5,10500) SITE
      READ(5,10500) SLAT
      READ(5,10500) DFE
      READ(5,10500) SLONG
      READ(5,10500) DFG
      READ(5,10500) SALT
      READ(5,10500) SJDATE
      READ(5,10500) SZHOUR
      READ(5,10500) C0
      C0=C0*0.3048
      READ(5,10500) C1
      READ(5,10500) VC
      VC=VC*1.51
      READ(5,10500) PRECIP
      READ(5,10500) T0
      T0=(5./9.)*(T0-32.)
      READ(5,10500) T1
      T1=(5./9.)*(T1-32.)
      READ(5,10500) D0
      READ(5,10500) S0
      READ(5,10500) ARE
      READ(5,10500) H3
      READ(5,10500) AST
      READ(5,10500) DLS
      READ(5,10500) XC
      READ(5,10500) TIME
```

```
C*METEOROLOGICAL CALCULATIONS.
      CALL KWIK1
C*ATMOSPHERIC  OPTICS.
      CALL KWIK2
C*ATMOSPHERIC DIFFUSION.
      CALL KWIK3
C*MUNITIONS EXPENDITURES.
      CALL KWIK4
C*PRINTOUT
      CALL KWIK5
      STOP
C*FORMAT STATEMENTS.
10500 FORMAT(A4)
10600 FORMAT(F10.0)
      END
      SUBROUTINE KWIK1
      COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,DO,D2,FC,FC,R2,SO,S3,TO,T1,
     2            Y1,VO,H3,AST,DLS,XO,TIME,H(2,2),C(4,2),T(4,4),
     3            U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      CHARACTER*8 WLNGTH
      COMMON /OUTPUT/ WLNGTH(4),SMOKE(2),GUN(2),PSC(5),R1,
     2                R(4,2),Q(4,2,2,2),P(4,2,2)
      COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOUR,DPE,DPG
      INTEGER PO
      INTEGER PSCTAB
      DIMENSION PSCTAB( 7,9)
      DATA PI /3.141592654/
      DATA ((PSCTAB(I,J),I=1,7),J=1,9)/
     1        1,1,2,3,4,5,5,
     2        1,2,2,3,4,5,5,
     3        1,2,3,4,4,5,6,
     4        2,2,3,4,4,5,5,
     5        2,2,3,4,4,4,5,
     6        2,3,3,4,4,4,5,
     7        3,3,4,4,4,4,5,
     8        3,3,4,4,4,4,4,
     9        3,4,4,4,4,4,4/
C*METEOROLOGICAL CALCULATIONS.
      IF(C1 .NE. 100.) GO TO 1000
      IF(CO .GT. 2133.5042) GO TO 1000
      I1=0
      I2=0
      GO TO 2300
1000  CONTINUE
C CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE.
      R9=PI/180.
      D9=180./PI
      SLAT1=SLAT*R9
      AO=((SJDATE-1.)*360.)/365.242
C CALCULATE SOLAR DECLINATION ANGLE (A4).
      A1=AO*R9
```

```
      A2=279.9349+A0
      A2=A2+(1.914827*SIN(A1))-(0.079525*COS(A1))
      A2=A2+(0.019938*SIN(2*A1))-(0.00162*COS(2*A1))
      A2=A2*R9
      A3=23.4438*R9
      A4=SIN(A3)*SIN(A2)
      A4=ASIN(A4)
C CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
      A5= 12.+(0.12357*SIN(A1))-(0.004289*COS(A1))
      A5=A5+(0.153809*SIN(2*A1))+(0.060753*COS(2*A1))
C CALCULATE SOLAR HOUR ANGLE (A6).
      A6=15.*(SZHOUR-A5)-SLONG
      A6=A6*R9
C CALCULATE SOLAR ALTITUDE (A7).
      A7=SIN(SLAT1)*SIN(A4)+COS(SLAT1)*COS(A4)*COS(A6)
      A7=ASIN(A7)
1100  CONTINUE
      A7=A7*D9
C CALCULATE INSOLATION CLASS NUMBER.
      I2=0
      IF(A7 .LE. 50.) GO TO 1200
      I2=4
      GO TO 1500
1200  CONTINUE
      IF(A7 .LE. 35.) GO TO 1300
      I2=3
      GO TO 1500
1300  CONTINUE
      IF(A7 .LE. 15.) GO TO 1400
      I2=2
      GO TO 1500
1400  CONTINUE
      IF(A7 .LE. 0.) GO TO 2200
      I2=1
C CALCULATE NET RADIATION INDEX FOR DAYTIME.
1500  CONTINUE
      I3=0
      IF(C1 .GT. 50.) GO TO 1600
      I3=I2
      GO TO 1900
1600  CONTINUE
      IF(CC .GT. 2133.6042) GO TO 1700
      I3=I2-2
      GO TO 1900
1700  CONTINUE
      IF(CC .GE. 4975.9055) GO TO 1800
      I3=I2-1
      GO TO 1900
1900  CONTINUE
      IF(C1 .NE. 100.) GO TO 1900
      I3=I2-1
```

```
1900  CONTINUE
      IF(I3 .NE. 0) GO TO 2000
      I3=I2
2000  CONTINUE
      IF(I3 .GT. 1) GO TO 2100
      I3=1
2100  CONTINUE
      I1=I3
      GO TO 2300
C COMPUTE NET RADIATION INDEX FOR NIGHTTIME.
2200  CONTINUE
      IF(C1 .GT. 40.) GO TO 2250
      I1=-2
      GO TO 2300
2250  CONTINUE
      I1=-1
C CALCULATE PASGUILL STABILITY CATAGORY.
2300  CONTINUE
      I4=0
      I5=0
      IF(I1 .NE. 4) GO TO 2400
      I4=1
2400  CONTINUE
      IF(I1 .NE. 3) GO TO 2420
      I4=2
2420  CONTINUE
      IF(I1 .NE. 2 ) GO TO 2440
      I4=3
2440  CONTINUE
      IF(I1 .NE. 1) GO TO 2450
      I4=4
2450  CONTINUE
      IF(I1 .NE. 0) GO TO 2480
      I4=5
2480  CONTINUE
      IF(I1 .NE. -1) GO TO 2500
      I4=6
2500  CONTINUE
      IF(I1 .NE. -2) GO TO 2520
      I4=7
2520  CONTINUE
      IF(SO .GE. 2.) GO TO 2540
      I5=1
      GO TO 2700
2540  CONTINUE
      IF(SO .GE. 4.) GO TO 2550
      I5=2
      GO TO 2700
2550  CONTINUE
      IF(SO .GE. 5.) GO TO 2590
      I5=3
```

```
      GO TO 2700
2590  CONTINUE
      IF(SO .GE. 7.) GO TO 2500
      I5=4
      GO TO 2700
2500  CONTINUE
      IF(SO .GE. 9.) GO TO 2520
      I5=5
      GO TO 2700
2520  CONTINUE
      IF(SO .GE. 10.) GO TO 2540
      I5=6
      GO TO 2700
2540  CONTINUE
      IF(SO .GE. 11.) GO TO 2550
      I5=7
      GO TO 2700
2550  CONTINUE
      IF(SO .GE. 12.) GO TO 2580
      I5=8
      GO TO 2700
2580  CONTINUE
      I5=9
2700  CONTINUE
      PO=PSCTAB(I4,I5)
C CALCULATE RELATIVE HUMIDITY.
      IF(T0 .GT. 0.) GO TO 2800
      A0=9.5
      B0=265.5
      IF(T0 .LE. 0.) GO TO 2850
2800  CONTINUE
      A0=7.5
      B0=237.3
2850  CONTINUE
      IF(T1 .GE. 0.) GO TO 2900
      A1=9.5
      B1=265.5
      IF(T1 .LE. 0.) GO TO 2950
2900  CONTINUE
      A1=7.5
      B1=237.3
2950  CONTINUE
      E0=6.11*10.**((A0*T0)/(B0+T0))
      E1=6.11*10.**((A1*T1)/(B1+T1))
      R0=(E1/E0)*100.
10999 FORMAT(F5.1,3X,F3.0)
      RETURN
      END
```

```
      SUBROUTINE KWIK2
      INTEGER PO
      COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,DO,D2,PO,RO,R2,SO,S3,TO,T1,
     2              Y1,VC,H3,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
     3              U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      DIMENSION B(4),E(4),F(4),G(4),CS(4,2),X(4)
      REAL LO,L1,L2,L3,L4,L5
      REAL NO
      DATA B/0.118,0.19,0.55,0.0/
      DATA E/25.7,7.5,5.1,5.0/
      DATA CS(1,1)/3.3/,CS(1,2)/2.45/,CS(2,1)/1.50/
      DATA CS(2,2)/2.00/,CS(3,1)/0.0/,CS(3,2)/0.25/
      DATA CS(4,1)/0.0/,CS(4,2)/0.32/
      DATA X/.05,.05,.05,.05/
      DATA PI /3.14159265/
      DATA NO/2HNO/
      DATA YES/3HYES/
      FNA(A)=EXP(-AST*A/2)
      FNB(B)=EXP(-B**2)
      FNC(C)=EXP(+C*AST*ALOG(0.1/F(J)))
      FND(D)=EXP(-D*AST/4.1)
C*ATMOSPHERIC OPTICS.
      V1=ALOG(VO)
      V2=V1*V1
      V3=V2*V1
      F(1)=1.5551-(0.9511*V1)-(0.0197*V2)+(0.0041*V3)
      F(1)=EXP(F(1))
      F(2)=1.5038l511-(0.99219519*V1)-(0.01557250l*V2)+(0.0035858З*V3)
      F(2)=EXP(F(2))
      F(3)=1.2394-(1.0435*V1)+(0.0059*V2)-(0.0015*V3)
      F(3)=EXP(F(3))
      F(4)=1.5175-(1.7147*V1)+(0.0001*V2)+(0.0425*V3)
      F(4)=EXP(F(4))
      G(1)=1.3305-(0.9925*V1)-(0.0753*V2)+(0.0125*V3)
      G(1)=EXP(G(1))
      G(2)=1.4819517O7-(0.92259929*V1)-(0.05550S417*V2)+
     2                  (0.01359O422*V3)
      G(2)=EXP(G(2))
      G(3)=1.5555-(0.9013*V1)-(0.0773*V2)+(0.0173*V3)
      G(3)=EXP(G(3))
      G(4)=1.5929-(0.9395*V1)-(0.0527*V2)+(0.0153*V3)
      G(4)=EXP(G(4))
      HO=0.0
      IF(AST .LT. 0.) AST=-AST
      AST=AST*(PI/180.)
      AST=SIN(AST)
      H4=0.
      IF(AST .NE. 0.) H4=1./AST
C CALCULATE PRECIPITABLE WATER.
      W=0.4477+(0.0329*T1)+(1.2E-03*T1*T1)+(1.84E-05*T1*T1*T1)
C CALCULATE AMOUNT OF WATER VAPOR IN PATH.
```

```
      L0=H3
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2886751*L4
      W0=0.5*L4*(FNA(L3+L5)+FNA(L3-L5))
      W1=W*W0
C CALCULATE TRANSMITTANCES FOR VISIBLE, NEAR,MID,FAR IR WAVELENGTHS.
      DO 5200 I=1,4
      IF(I .NE. 4) GO TO 3500
      T(I,1)=EXP(-0.0591*W1)
      GO TO 3700
C CALCULATE TRANSMITTANCE OWING TO ABSORPTION BY WATER VAPOR.
3500  CONTINUE
      L0=(B(I)*SQRT(W1*PI)/2.)
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2886751*L4
      T2=0.5*L4*(FNB(L3+L5)+FNB(L3-L5))
      T(I,1)=(2./SQRT(PI))*T2
      T(I,1)=1-T(I,1)
3700  CONTINUE
C CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
      IF(PRECIP .EQ. NO)  GO TO 3900
      T(I,2)=1.0
      GO TO 4100
3900  CONTINUE
      IF(VC .GE. E(I))  GO TO 4000
      L0=H4
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2886751*L4
      T3=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
      T4=EXP(-F(I)*T3)
      L1=H4
      L2=H3
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2886751*L4
      T5=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
      T5=EXP(-0.129*T5)
      T(I,2)=T4*T5
      GO TO 4100
4000  CONTINUE
      L0=H3
      L1=H0
```

```
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2886751*L4
      T7=0.5*L4*(FND(L3+L5)+FND(L3-L5))
      T(I,2)=EXP(-F(I)*T7)
 4100 CONTINUE
C CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
      IF(PRECIP .EQ. YES)  GO TO 4400
 4300 CONTINUE
      T(I,3)=1.
      GO TO 4500
 4400 CONTINUE
      IF(VC .GT. 20.)  GO TO 4300
      T(I,3)=EXP(-H3*G(I))
 4500 CONTINUE
C CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
 4600 CONTINUE
      T(I,4)=X(I)/(T(I,1)*T(I,2)*T(I,3))
      IF(T(I,4) .LE. 1.)  GO TO 4700
      T(I,4)=1.
 4700 CONTINUE
C CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
      IF(T(I,4) .NE. 0.)  GO TO 5000
      DO 4900 J=1,2
      C(I,J)=0.
 4900 CONTINUE
      GO TO 5200
 5000 CONTINUE
      DO 5100 K=1,2
      IF(CS(I,K) .NE. 0.)GO TO 5050
      C(I,K)=0.
      GO TO 5100
 5050 CONTINUE
      C(I,K)=ALOG(T(I,4))/(-CS(I,K))
 5100 CONTINUE
 5200 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE KWIK3
      INTEGER PO
      COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,DO,D2,PO,RO,R2,SO,S3,TO,T1,
     2              Y1,VC,H3,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
     3              U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      DIMENSION A(6),S(6,3),D(6,3)
      DIMENSION W(6)
      DATA A/0.4,0.32,0.22,0.144,0.102,0.076/
      DATA ((S(I,J),J=1,3),I=1,6)/
     1         0.139095257,0.015017294,-1.02591E-04,
     2         0.122097543,0.01097037,-5.90135E-05,
     3         0.110104377,0.010942953,-5.73401E-05,
     4         0.097549932,0.010419519,-5.93502E-05,
     5         0.070772155,7.27284E-03,-4.60055E-05,
     6         0.055497093,5.55309E-03,-4.01795E-05/
      DATA ((D(I,J),J=1,3),I=1,6)/
     1         0.944914915,-4.95195E-03,3.7037E-05,
     2         0.994903551,-4.93951E-03,3.59147E-05,
     3         0.954792358,-4.92715E-03,3.47924E-05,
     4         0.915025935,-5.07407E-03,4.7139E-05,
     5         0.785025935,-5.07407E-03,4.7139E-05,
     6         0.725015713,-5.05173E-03,4.50157E-05/
      DATA W/0.015,0.015,0.015,0.015,0.015,0.015/
      DATA PI /3.141592654/
C*ATMOSPHERIC DIFFUSION CALCULATIONS.
      A1=-1.24+1.19*ALOG10(ARE)
      Z1=10.**A1
      A2=ABS(DLS-DO)*(PI/180.)
      R2=SQRT(13.59/(13.59*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
      Y1=1.09521547+(0.02905994*RO)-(4.9575E-04*RO*RO)+
     2              (4.92E-06*RO*RO*RO)
      Y2=3.359059144+(0.040502571*RO)-(1.15301E-03*RO*RO)+
     2              (1.33942E-05*RO*RO*RO)
      C2=S(PO,1)+S(PO,2)*Z1+S(PO,3)*Z1**2
      D1=D(PO,1)+D(PO,2)*Z1+D(PO,3)*Z1**2
      D2=1/D1
      IF(SO .NE. 0.) GO TO 5200
      SO=1.0
 5200 CONTINUE
      S3=SO*0.515
      DO 5400 I=1,4
C*CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
      DO 5300 K=1,2
      IF(I .LT. 3 .AND. PO  .GT.4) GO TO 5300
      S1=U(K,1)+0.74*A(PO)*100.**0.9
      S2=U(K,2)+0.557*C2*100.**D1
      V(K)=(W(PO)*Y2*H(K,2))/(PI*S1*S2)
 5300 CONTINUE
 5400 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE KWIK4
      INTEGER PO
      REAL ME
      COMMON /KWIK/ PRECIP,ARE,C0,C1,C2,D0,D2,P0,R0,R2,S0,S3,T0,T1,
     2              Y1,VC,H3,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
     3              U(2,2),V(2),Y(4,2,2),Z(4,2,2)
      CHARACTER*8 WLNGTH
      COMMON /OUTPUT/ WLNGTH(4),SMOKE(2),GUN(2),PSC(5),R1,
     2                R(4,2),Q(4,2,2,2),F(4,2,2)
      DIMENSION ME(2)
      DATA ME/0.4,0.4/
C*MUNITIONS EXPENDITURES.
      DO 5900 I=1,4
C* CALCULATE INITIAL SHELL SPACING FOR HC SMOKE
      DO 5900 K=1,2
      IF(I .GT. 2) GO TO 5100
      Y(I,1,K)=45.*S3
C* CALCULATE SUSTAINING SHELL SPACING FOR HC SMOKE
      IF(C(I,1) .NE. 0.) GO TO 5500
      Y(I,2,K)=0.
      GO TO 5600
 5500 CONTINUE
      Y(I,2,K)=1/R2*((0.731*ME(K)*Y1*F(K,1))/(C2*S3*C(I,1)))**D2
      IF(Y(I,2,K) .GT. X0) Y(I,2,K)=X0
 5600 CONTINUE
      IF(Y(I,2,K) .NE. 0.) GO TO 5700
      Q(I,1,K,1)=1.
      Q(I,2,K,1)=1.
      GO TO 5900
 5700 CONTINUE
C* CALCULATE INITIAL VOLLEY FOR HC SMOKE
      IF(Y(I,1,K) .GT. Y(I,2,K)) Y(I,1,K)=Y(I,2,K)
      Q(I,1,K,1)=XC/Y(I,1,K)
      Q5=AINT(Q(I,1,K,1))
      Q5=Q(I,1,K,1)-Q5
      IF(Q5 .EQ. 0.) GO TO 5800
      Q(I,1,K,1)=Q5+1.
 5800 CONTINUE
C* CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)
      Q(I,2,K,1)=X0/Y(I,2,K)
      Q5=AINT(Q(I,2,K,1))
      Q5=Q(I,2,K,1)-Q5
      IF(Q5 .EQ. 0.) GO TO 5900
      Q(I,2,K,1)=Q5+1.
 5900 CONTINUE
C* CALCULATE RATE OF FIRE FOR HC SMOKE
      R1=0.5
      IF(C(I,1) .NE. 0.) GO TO 5000
      R1=0.
 5000 CONTINUE
C* CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE)
```

```
      P(I,K,1)=Q(I,1,K,1)+(R1*TIME-1)*Q(I,2,K,1)
      Q5=AINT(P(I,K,1))
      QS=P(I,K,1)-Q5
      IF(QS .EQ. 0.) GO TO 5100
      P(I,K,1)=Q5+1.
5100  CONTINUE
      IF(I .LT. 3 .AND. P3 .GT.0) GO TO 5900
C* SHELL SPACING (Z( )) AND VOLLEYS (Q( )) - WP SMOKE
      IF(C(I,2) .NE. 0.) GO TO 5200
      Z(I,1,K)=0.
      Z(I,2,K)=0.
      Q(I,1,K,2)=0.
      Q(I,2,K,2)=0.
      GO TO 5400
5200  CONTINUE
      IF (I .LT. 3) GO TO 5250
      IF(I .GT. 2) Q(I,1,K,2)=0.5*C(I,2)/V(K)
      GO TO 5300
5250  CONTINUE
      Z(I,1,K)=V(K)/C(I,2)*100.
      Z(I,2,K)=Z(I,1,K)
      Q(I,1,K,2)=XO/Z(I,2,K)
5300  CONTINUE
      Q5=AINT(Q(I,1,K,2))
      QS=Q(I,1,K,2)-Q5
      IF(QS .EQ. 0.) GO TO 5350
      Q(I,1,K,2)=Q5+1.
5350  CONTINUE
      Q(I,2,K,2)=Q(I,1,K,2)
5400  CONTINUE
C* RATE OF FIRE FOR WP SMOKE
      IF(C(I,2) .NE. 0.) GO TO 5425
      R(I,K)=0.
      GO TO 5500
5425  CONTINUE
      IF(I .GT. 2) GO TO 5450
      R(I,K)=(Z(I,2,K)+50.)/53
      GO TO 5475
5450  CONTINUE
      R(I,K)=120./53
5475  CONTINUE
      R(I,K)=R(I,K)/20.
      R5=AINT(R(I,K))
      RS=R(I,K)-R5
      IF(RS .LT. 0.5) GO TO 5500
      R5=R5+1.
5500  CONTINUE
      IF(R5 .NE. 0.) GO TO 5550
      R5=1.
5550  CONTINUE
      R(I,K)=R5*20./50.
```

```
      R(I,K)=1./R(I,K)
      IF(R(I,K) .GE. 1.) GO TO 5500
      R(I,K)=1.
5500  CONTINUE
C* CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP)
      IF(C(I,2) .NE. 0.) GO TO 5550
      P(I,K,2)=C.
      GO TO 5700
5550  CONTINUE
      IF(I .GT. 2) GO TO 5700
      P(I,K,2)=Q(I,1,K,2)+Q(I,2,K,2)*(TIME*R(I,K)-1.)
      GO TO 5750
5700  CONTINUE
      P(I,K,2)=Q(I,2,K,2)*(XO/50.+1.)*(TIME*R(I,K)-1.)
5750  CONTINUE
      Q5=AINT(P(I,K,2))
      Q5=P(I,K,2)-Q5
      IF(Q5 .EQ. 0.) GO TO 5900
      P(I,K,2)=Q5+1.
      GO TO 5900
5900  CONTINUE
C* CALCULATIONS FOR E AND F STABILIY CAT (STABLE FLOW)
C* INITIAL SHELL SPACING FOR WP SMOKE
      IF(I .EQ. 1 .AND. K .EQ. 1) Z(I,1,K)=100.
      IF(I .EQ. 2 .AND. K .EQ. 1) Z(I,1,K)=50.
      IF(I .LT. 3 .AND. K .EQ. 2) Z(I,1,K)=100.
C* SUSTAINING SHELL SPACING FOR WP SMOKE
      IF(I .EQ. 1 .AND. K .EQ. 1) Z(I,2,K)=100.
      IF(I .EQ. 1 .AND. K .EQ. 2) Z(I,2,K)=200.
      IF(I .EQ. 2 .AND. K .EQ. 1) Z(I,2,K)=50.
      IF(I .EQ. 2 .AND. K .EQ. 2) Z(I,2,K)=100.
C* INITIAL VOLLEY FOR WP SMOKE
      Q(I,1,K,2)=XO/Z(I,1,K)+1.
C* SUSTAINING VOLLEY FOR WP SMOKE
      Q(I,2,K,2)=XO/Z(I,2,K)+1.
C* RATE OF FIRE FOR WP SMOKE
      IF(K .EQ. 1) R(I,1)=2.
      IF(K .EQ. 2) R(I,2)=1.
C* TOTAL NUMBER OF ROUNDS REQUIRED (WP)
      P(I,K,2)=Q(I,1,K,2)+Q(I,2,K,2)*(TIME*R(I,K)-1.)
      Q5=AINT(P(I,K,2))
      Q5=P(I,K,2)-Q5
      IF(Q5 .EQ. 0.) GO TO 5900
      P(I,K,2)=Q5+1.
5900  CONTINUE
      RETURN
      END

      SUBROUTINE KWIK5
      INTEGER PO
      COMMON /KWIK/ PRECIP,AHE,CO,C1,C2,LO,PZ,FO,FC,RZ,SO,S3,TO,T1,
     2              Y1,VO,H3,AST,DLS,XO,TIME,H(2,2),C(3,2),T(3,3),
     3              U(2,2),V(2),Y(3,2,2),Z(3,2,2)
      COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOUR,DFE,DFG
      CHARACTER*5 WLNGTH
      COMMON /OUTPUT/ WLNGTH(8),SMOKE(2),GUN(2),PSC(5),R1,
```

```
     2                    R(4,2),Q(4,2,2,2),F(4,2,2)
C* PRINT INPUT DATA
      WRITE(5,10000)
      WRITE(5,10121)
      WRITE(5,10300)
      WRITE(5,10400)
      WRITE(5,10200)
      WRITE(5,10500) SITE
      WRITE(5,10600) DFE,SLAT
      WRITE(5,10700) DFG,SLONG
      WRITE(5,10800) SALT
      WRITE(5,10900) SJDATE
      WRITE(5,11000) SZHOUR
      WRITE(5,11100) C0
      WRITE(5,11200) C1
      WRITE(5,11300) V0
      WRITE(5,11400) PRECIP
      WRITE(5,11500) T0
      WRITE(5,11600) T1
      WRITE(5,11700) D0
      WRITE(5,11800) S0
      WRITE(5,11900) ARE
      WRITE(5,12000) FSC(FC)
      WRITE(5,12100) R0
      WRITE(5,10000)
C* PRINT MUNITION EXPENDITURES
      DO 7100 I=1,4
      WRITE(5,10130)
      WRITE(5,12200) WLNGTH(I)
      WRITE(5,10130)
      WRITE(5,12300)
      WRITE(5,12400) X0,TIME
      WRITE(5,10200)
      IF(I .GT. 2) GO TO 7000
      WRITE(5,12500) SMOKE(I)
      WRITE(5,10200)
      WRITE(5,12600) GUN(I)
      WRITE(5,10100)
      WRITE(5,12700)
      WRITE(5,12800)
      WRITE(5,12900) Q(I,1,1,1),Y(I,1,1)
      WRITE(5,13000) Q(I,2,1,1),R1,Y(I,2,1),P(I,1,1)
      WRITE(5,10200)
```

```
      WRITE(5,12500) GUN(2)
      WRITE(5,10100)
      WRITE(5,12700)
      WRITE(5,12800)
      WRITE(5,12900) Q(I,1,2,1),Y(I,1,2)
      WRITE(5,13000) Q(I,2,2,1),R1,Y(I,2,2),P(I,2,1)
      WRITE(5,10200)
      WRITE(5,12500) SMOKE(2)
      WRITE(5,10200)
      WRITE(5,12500) GUN(1)
      WRITE(5,10100)
      WRITE(5,12700)
      WRITE(5,12800)
      WRITE(5,12900) Q(I,1,1,2),Z(I,2,1)
      IF(PC .GT. 4) R(I,1)=2.
      WRITE(5,13000) Q(I,2,1,2),R(I,1),Z(I,1,1),P(I,1,2)
      WRITE(5,10200)
      WRITE(5,12500) GUN(2)
      WRITE(5,10100)
      WRITE(5,12700)
      WRITE(5,12800)
      WRITE(5,12900) Q(I,1,2,2),Z(I,1,2)
      IF(PC .GT. 4) R(I,2)=1.
      WRITE(5,13000) Q(I,2,2,2),R(I,2),Z(I,2,2),P(I,2,2)
      WRITE(5,10000)
      IF(I .LT. 3) GO TO 7100
7000  CONTINUE
      WRITE(5,12500) SMOKE(2)
      WRITE(5,10100)
      WRITE(5,13100)
      WRITE(5,13200)
      WRITE(5,13300) GUN(1),Q(I,2,1,2),R(I,1),P(I,1,2)
      WRITE(5,13300) GUN(2),Q(I,2,2,2),R(I,2),P(I,2,2)
      WRITE(5,10000)
7100  CONTINUE
      RETURN
C* FORMAT STATEMENTS.
10000 FORMAT(1H1)
10100 FORMAT(1H )
10200 FORMAT(1H0)
10130 FORMAT(///)
10140 FORMAT(////)
10121 FORMAT(////////////////)
10300 FORMAT(55X,21HMUNITION EXPENDITURES)
10400 FORMAT(55X,19HFOR HC AND WP SMOKE)
10500 FORMAT(45X,35HID                                  = ,A7)
10600 FORMAT(45X,35HLATITUDE                - DEG       = ,A2,F5.2)
10700 FORMAT(45X,35HLONGITUDE               - DEG       = ,A2,F5.2)
10800 FORMAT(45X,35HALTITUDE                - KM        = ,F7.2)
10900 FORMAT(45X,35HJULIAN DATE             - DAY       = ,F5.0)
```

```
11000 FORMAT(45X,35HZULU TIME                  - HOUR    =  ,F5.0)
11100 FORMAT(45X,35HCEILING                    - METERS  =  ,F7.2)
11200 FORMAT(45X,35HCLOUD COVER                - PERCENT =  ,F7.2)
11300 FORMAT(45X,35HVISIBILITY                 - KM      =  ,F7.2)
11400 FORMAT(45X,35HPRECIPITATION                        =  ,4X,A3)
11500 FORMAT(45X,35HTEMPERATURE                - DEG C   =  ,F7.2)
11600 FORMAT(45X,35HDEW POINT                  - DEG C   =  ,F7.2)
11700 FORMAT(45X,35HWIND DIRECTION             - DEG     =  ,F7.2)
11800 FORMAT(45X,35HWIND SPEED                 - KNOTS   =  ,F7.2)
11900 FORMAT(45X,35HAVE ROUGHNESS ELEMENT      - CM      =  ,F7.2)
12000 FORMAT(45X,35HPASQUILL STABILITY CATEGORY          =  ,3X,A9)
12100 FORMAT(45X,35HRELATIVE HUMIDITY                    =  ,F7.2)
12200 FORMAT(52X,A9)
12300 FORMAT(47X,37H                         METERS MINUTES)
12400 FORMAT(47X,23HSCREEN LENGTH/DURATION:,1X,F5.0,4X,F3.0)
12500 FORMAT(59X,A2,13H SMOKE SCREEN)
12600 FORMAT(59X,A3,11HMM HOWITZER)
12700 FORMAT(47X,37HVOLLEY       GUNS RATE/ SPACING ROUNDS)
12800 FORMAT(47X,30H                  MIN    METERS)
12900 FORMAT(47X,11HINITIAL:    ,F5.0,5X,F9.0)
13000 FORMAT(47X,11HSUSTAINING:,F5.0,F5.1,F9.0,F7.0)
13100 FORMAT(47X,31H         ROUNDS/    RATE/    TOTAL)
13200 FORMAT(47X,32H        50 METERS  MINUTE   ROUNDS)
13300 FORMAT(47X,A3,5HMM:   ,F5.0,5X,F3.0,4X,F7.0)
      END
```

APPENDIX I

KWIK ALGORITHM
GLOSSARY OF MNEMONICS
(BASIC/HP85, HP9845, AND APPLE II)

1.	CO	Ceiling - feet
2.	CI	Cloud cover - percent
3.	VO	Visibility - miles
4.	TO	Temperature - degrees Fahrenheit
5.	T1	Dewpoint - degrees Fahrenheit
6.	DO	Wind direction - degrees
7.	SO, S3	Windspeed - knots, meters per second
8.	PO	Atmospheric stability category
9.	H3	Slant range to target - kilometers
10.	RO	Relative humidity - percent
11.	XO	Smoke screen length - meters
12.	T2	Smoke screen duration - minutes
13.	S	Angle of sight to target - degrees
14.	AO	Direction of line of sight - degrees
15.	Y	Average roughness element - centimeters
16.	Z	Roughness length - centimeters
17.	P(7,9)	Table of stability categories depending upon solar altitude and windspeed
18.	T(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19.	C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20.	B(4)	Absorption coefficient error function
21.	G(4)	Scale height for Mie scattering
22.	H(4)	Haze and fog attenuation coefficients
23.	R(4)	Precipitation attenuation coefficients
24.	D(2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid, and far infrared wavelengths
25.	A(6)	Coefficients to compute sigma y
26.	S(6,3), D5(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27.	Y1, Y2	Yield factors for HC and WP
28.	LO,L1,ZO,JO,HO	Latitude, longitude, altitude, Julian date and Zulu time data
29.	J(4,2), P5(4,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30.	E(4,2), F(4,2) G5(4,2), Q9(4,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31.	R1, R5(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32.	H5(2,2)	Unit (per gun) source strength

	33. Q(2)	Munition efficiency for 105- and 155-mm howitzers for HC smoke
	34. U(2,2)	WP volume source sigmas (σ_{yo} and σ_{zo}) for 105- and 155-mm howitzers
	35. V(2)	Stability dependent crosswind integrated concentration for WP smoke
	36. W(6)	Constant (K) related to stability category for WP
	37. X(4)	Wavelength threshold levels
	38. I(4,2), Y(4,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
	39. Z(4,2), L(4,2)	Shell spacing for 105- and 155-mm howitzers for WP smoke
	40. I$(4)	Met site identifier
*	41. O$(6)	Stability category indicator
	42. A$(8)	Wavelength indicator
	43. P	Precipitation indicator
*	44. H$(1), J$(1)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
	45. I	Index for wavelength algorithms
	46. J	Index for smoke algorithms
	47. K	Index for gun (105- and 155-mm howitzers) algorithms

* On APPLE II these are omitted.

APPENDIX J

HP 85 (BASIC) ALGORITHM

```
10 REM KWIK ALGORIT       17.81
             RICARDO PENA (ASL)
20 REM KWIK  METEOROLOGICAL INP
   UT) AND METEOROLOGICAL CALCU
   LATIONS
30 CLEAR
40 OPTION BASE 1
50 PRINTER
60 DIM C(4,2),T(4,4),V(2),W(6),
   Y(4,2),Z(4,2)
70 DIM I$[4],P(7,9),O$[6],H$[1]
   ,J$[1]
80 ! FIXED 2
90 PRINT
100 PRINT
110 PRINT "      MUNITION EXPENDI
    TURES"
120 PRINT "       FOR HC AND WP S
    MOKE"
130 PRINT
140 PRINT
150 DISP "SITE ID";
160 INPUT I$
170 DISP "LATITUDE OF SITE- DEG"
    ;
180 INPUT L0
190 REM DIRECTION FROM EQUATOR-
    N OR S
200 H$="N"
210 DISP "LONGITUDE OF SITE - DE
    G";
220 INPUT L1
230 DISP "DIRECTION FROM GREENWI
    CH- E OR W";
240 INPUT J$
250 DISP "JULIAN DATE OF MET OBS
    ERVATION  (001-366)";
260 INPUT J0
270 DISP "ZULU TIME OF MET OSERV
    ATION-HR  (01-24)";
280 INPUT H0
290 DISP "CEILING - FEET";
300 INPUT C0
310 C0=C0*.3048
320 DISP "CLOUD COVER - PERCENT"
    ;
330 INPUT C1
340 DISP "VISIBILITY - MILES";
350 INPUT V0
360 V0=V0*1.61
370 DISP "PRECIPITATION - 1=YES
    0=NO";
380 INPUT P
390 DISP "TEMPERATURE - DEG F";
400 INPUT T0
410 T0=5/9*(T0-32)
420 DISP "DEW POINT - DEG F";
430 INPUT T1
440 T1=5/9*(T1-32)
450 DISP "WIND DIRECTION - DEGS"
    ;
```

AD-A121 542 KWIK SMOKE OBSCURATION MODEL: USER'S GUIDE(U) ARMY ELECTRONICS RESEARCH AND DEVELOPMENT COMMAND WSMR NM ATMOSPHERIC SCIENCES LAB R PENA SEP 82 2/2

UNCLASSIFIED ERADCOM/ASL-TR-0120 F/G 17/4 NL

END

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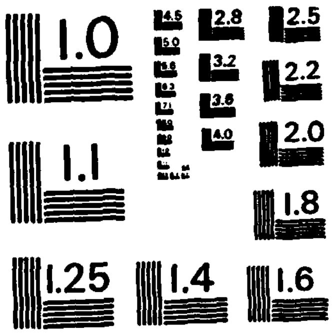

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
460 INPUT D0
470 DISP "WIND SPEED KNOTS";
480 INPUT S0
490 DISP "AVE ROUGHNESS ELEMENT
    - CM";
500 INPUT Y
510 PRINT USING 520 ; I$
520 IMAGE "ID
     =   ",AAA
530 PRINT USING 540 ; H$[1];L0
540 IMAGE "LATITUDE             DEG
     = ",A,DDDD.D
550 PRINT USING 560 ; J$[1];L1
560 IMAGE "LONGITUDE            DEG
     = ",A,DDDD.D
570 PRINT USING 580 ; J0
580 IMAGE "JULIAN DATE          DAY
     =   ",DDDD
590 PRINT USING 600 ; H0
600 IMAGE "ZULU TIME            HR
     =   ",DDDD
610 PRINT USING 620 ; C0
620 IMAGE "CEILING              M
     =   ",DDDD.D
630 PRINT USING 640 ; C1
640 IMAGE "CLOUD COVER          %
     =   ",DDDD
650 PRINT USING 660 ; V0
660 IMAGE "VISIBILITY           KM
     =   ",DDDD.D
670 P$="NO"
680 IF P=0 THEN 700
690 P$="YES"
700 PRINT USING 710 ; P$
710 IMAGE "PRECIPITATION
     =   ",AAA
720 PRINT USING 730 ; T0
730 IMAGE "TEMPERTURE           DEG
     =   ",DDDD.D
740 PRINT USING 750 ; T1
750 IMAGE "DEWPOINT             DEG
     =   ",DDDD.D
760 PRINT USING 770 ; D0
770 IMAGE "WIND DIRECTION       DEG
     =   ",DDDD.D
780 PRINT USING 790 ; S0
790 IMAGE "WIND SPEED           KTS
     =   ",DDDD.D
800 PRINT USING 810 ; Y
810 IMAGE "ROUGHNESS ELEMENT CM
     =   ",DDDD.D
820 FOR J=1 TO 9
830 FOR I=1 TO 7
840 READ P(I,J)
850 NEXT I
860 NEXT J
870 READ O$
880 IF J$<>"E" THEN 910
890 L1=-L1
900 REM MET CALCULATIONS.
```

```
910 IF C1<>100 THEN 960
920 IF C0 3133.6042 THEN 960
930 I1=0
940 I2=0
950 GOTO 1570
960 REM CALCULATE ANGULAR FRACTI
    ON OF A YEAR FOR A GIVEN JUL
    IAN DATE (A0)
970 R9=PI/180
980 D9=180/PI
990 L0=L0*R9
1000 A0=(J0-1)*360/365.242
1010 REM CALCULATE SOLAR DECLINA
     TION ANGLE (A4).
1020 A1=A0*R9
1030 A2=279.9348+A0
1040 A2=A2+1.914827*SIN(A1)-.079
     525*COS(A1)
1050 A2=A2+.019938*SIN(2*A1)-.00
     162*COS(2*A1)
1060 A2=A2*R9
1070 A3=23.4438*R9
1080 A4=SIN(A3)*SIN(A2)
1090 A4=ATN(A4/SQR(1-A4*A4+1.E-9
     9))
1100 REM CALCULATE THE TIME OF M
     ERIDIAN PASSAGE - TRUE SOLA
     R NOON (A5)
1110 A5=12+.12357*SIN(A1)-.00428
     9*COS(A1)
1120 A5=A5+.153809*SIN(2*A1)+.06
     0783*COS(2*A1)
1130 REM CALCULATE SOLAR HOUR AN
     GLE (A6)
1140 A6=15*(H0-A5)-L1
1150 A6=A6*R9
1160 REM CALCULATE SOLAR ALTITUD
     E (A7)
1170 A7=SIN(L0)*SIN(A4)+COS(L0)*
     COS(A4)*COS(A6)
1180 A7=ATN(A7/SQR(1-A7*A7+1.E-9
     9))
1190 A7=A7*D9
1200 REM CALCULATE INSOLATION CA
     LSS NUMBER.
1210 I2=0
1220 IF A7<=60 THEN 1250
1230 I2=4
1240 GOTO 1330
1250 IF A7<=35 THEN 1280
1260 I2=3
1270 GOTO 1330
1280 IF A7<=15 THEN 1310
1290 I2=2
1300 GOTO 1330
1310 IF A7<=0 THEN 1520
1320 I2=1
1330 REM CALCULATE NET RADIATION
      INDEX FOR DAYTIME.
1340 I3=0
```

```
1350 IF C1>50 THEN 1380
1360 I3=I2
1370 GOTO 1460
1380 IF C0>=2133.6042 THEN 1410
1390 I3=I2-2
1400 GOTO 1460
1410 IF C0>=4876.8096 THEN 1440
1420 I3=I2-1
1430 GOTO 1460
1440 IF C1<>100 THEN 1460
1450 I3=I2-1
1460 IF I3<>0 THEN 1480
1470 I3=I2
1480 IF I3>1 THEN 1500
1490 I3=1
1500 I1=I3
1510 GOTO 1570
1520 REM CALCULATE NET RADIATION
      INDEX FOR NIGHTTIME
1530 IF C1>40 THEN 1560
1540 I1=-2
1550 GOTO 1570
1560 I1=-1
1570 REM CALCULATE PASQUILL STAB
     ILITY CATEGORY.
1580 I4=0
1590 I5=0
1600 IF I1<>4 THEN 1620
1610 I4=1
1620 IF I1<>3 THEN 1640
1630 I4=2
1640 IF I1<>2 THEN 1660
1650 I4=3
1660 IF I1<>1 THEN 1680
1670 I4=4
1680 IF I1<>0 THEN 1700
1690 I4=5
1700 IF I1<>-1 THEN 1720
1710 I4=6
1720 IF I1<>-2 THEN 1740
1730 I4=7
1740 IF S0>=2 THEN 1770
1750 I5=1
1760 GOTO 1990
1770 IF S0>=4 THEN 1800
1780 I5=2
1790 GOTO 1990
1800 IF S0>=6 THEN 1830
1810 I5=3
1820 GOTO 1990
1830 IF S0>=7 THEN 1860
1840 I5=4
1850 GOTO 1990
1860 IF S0>=8 THEN 1890
1870 I5=5
1880 GOTO 1990
1890 IF S0>=10 THEN 1920
1900 I5=6
1910 GOTO 1990
1920 IF S0>=11 THEN 1950
```

```
1930 I5=7
1940 GOTO 1990
1950 IF S0>=12 THEN 1980
1960 I5=8
1970 GOTO 1990
1980 I5=9
1990 P0=P(I4,I5)
2000 REM CALCULATE RELATIVE HUMI
     DITY
2010 IF T0>0 THEN 2050
2020 A0=9.5
2030 B0=265.5
2040 GOTO 2070
2050 A0=7.5
2060 B0=237.3
2070 IF T1>0 THEN 2110
2080 A1=9.5
2090 B1=265.5
2100 GOTO 2130
2110 A1=7.5
2120 B1=237.3
2130 E0=6.11*10^(A0*T0/(B0+T0))
2140 E1=6.11*10^(A1*T1/(B1+T1))
2150 R0=E1/E0*100
2160 PRINT
2170 PRINT
2180 PRINT USING 2190 ; Q$[P0,P0
     ]
2190 IMAGE "PASQUILL STABILITY C
     ATEGORY ",A
2200 PRINT USING 2210 ; R0
2210 IMAGE "RELATIVE HUMIDITY
            ",DDDD.D
2220 PRINT
2230 REM PASQUILL STABILITY CATE
     GORY DATA
2240 DATA 1,1,2,3,4,6,6
2250 DATA 1,2,2,3,4,6,6
2260 DATA 1,2,3,4,4,5,6
2270 DATA 2,2,3,4,4,5,6
2280 DATA 2,2,3,4,4,4,5
2290 DATA 2,3,3,4,4,4,5
2300 DATA 3,3,4,4,4,4,5
2310 DATA 3,3,4,4,4,4,4
2320 DATA 3,4,4,4,4,4,4
2330 DATA "ABCDEF"
2340 REM KWIK: ATMOSPHERIC OPTIC
     S AND SMOKE CONCENTRATION C
     ALCULATIONS
2350 DIM B(4),G(4),H(4),R(4),D(2
     ),X(4)
2360 ! FIXED 2
2370 FOR I=1 TO 4
2380 READ B(I),G(I),X(I)
2390 NEXT I
2400 V1=LOG(V0)
2410 V2=V1*V1
2420 V3=V2*V1
2430 H(1)=1.5551-.9811*V1-.0197*
     V2+.0041*V3
```

```
2440 H(1)=EXP(H(1))
2450 H(2)=1.50381511-.992319519*
     V1-.015972801*V2+.00368583*
     V3
2460 H(2)=EXP(H(2))
2470 H(3)=1.2394-1.0436*V1+.0099
     *V2-.0016*V3
2480 H(3)=EXP(H(3))
2490 H(4)=1.5176-1.7147*V1+.0001
     *V2+.0428*V3
2500 H(4)=EXP(H(4))
2510 R(1)=1.3306-.8825*V1-.0753*
     V2+.0129*V3
2520 R(1)=EXP(R(1))
2530 R(2)=1.481951707-.922595829
     *V1-.065509417*V2+.01368042
     2*V3
2540 R(2)=EXP(R(2))
2550 R(3)=1.5556-.9013*V1-.0773*
     V2+.0173*V3
2560 R(3)=EXP(R(3))
2570 R(4)=1.5928-.9396*V1-.0627*
     V2+.0168*V3
2580 R(4)=EXP(R(4))
2590 H0=0
2600 DISP "SLANT RANGE TO TARGET
      - KM";
2610 INPUT H3
2620 PRINT USING 2630 ; H3
2630 IMAGE "SLANT RANGE TO TARGE
     T - KM  ",DDD
2640 DISP "VERT ANGLE OF SIGHT T
     O TARGET - DEG";
2650 INPUT S
2660 PRINT USING 2670 ; S
2670 IMAGE "ANGLE OF SIGHT TO TG
     T - DEG ",DDD
2680 IF S>=0 THEN 2700
2690 S=-S
2700 S=S*(PI/180)
2710 S=SIN(S)
2720 H4=0
2730 IF S=0 THEN 2760
2740 H4=1/S
2750 REM CALCULATE PRECIPITABLE
     WATER
2760 W=.4477+.0328*T1+.0012*T1*T
     1+.0000184*T1*T1*T1
2770 REM CALCULATE AMOUNT OF WAT
     ER IN PATH
2780 DEF FNA(A) = EXP(-S*A/2)
2790 L0=H3
2800 L1=H0
2810 L2=L0
2820 L3=.5*(L1+L2)
2830 L4=L2-L1
2840 L5=.2886751*L4
2850 W0=.5*L4*(FNA(L3+L5)+FNA(L3
     -L5))
2860 W1=W*W0
```

```
2870 REM CALCULATE TRANSMITTANCE
     S FOR VISUAL, NEAR, MID AND
      FAR IR WAVELENGTHS
2880 FOR I=1 TO 4
2890 REM CALCULATE TRANSMITTANCE
     S OWING TO ABSORPTION BY WA
     TER VAPOR.
2900 IF I<>4 THEN 2930
2910 T(I,1)=EXP(-.0681*W1)
2920 GOTO 3030
2930 DEF FNB(B) = EXP(-B^2)
2940 L0=B(I)*SQR(W1*PI)/2
2950 L1=H0
2960 L2=L0
2970 L3=.5*(L1+L2)
2980 L4=L2-L1
2990 L5=.2886751*L4
3000 M2=.5*L4*(FNB(L3+L5)+FNB(L3
     -L5))
3010 T(I,1)=2/SQR(PI)*M2
3020 T(I,1)=1-T(I,1)
3030 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY HA
     ZE AND FOG.
3040 IF P=0 THEN 3070
3050 T(I,2)=1
3060 GOTO 3350
3070 IF V0>=G(I) THEN 3270
3080 DEF FNC(C) = EXP(C*S*LOG(.1
     /H(I)))
3090 L0=H4
3100 L1=H0
3110 L2=L0
3120 L3=.5*(L1+L2)
3130 L4=L2-L1
3140 L5=.2886751*L4
3150 T3=  .5*L4*(FNC(L3+L5)+FNC(
     L3-L5))
3160 T4=EXP(-H(I)*T3)
3170 DEF FND(D) = EXP(-D*S/4.1)
3180 L1=H4
3190 L2=H3
3200 L3=.5*(L1+L2)
3210 L4=L2-L1
3220 L5=.2886751*L4
3230 T5=.5*L4*(FND(L3+L5)+FND(L3
     -L5))
3240 T6=EXP(-.128*T5)
3250 T(I,2)=T4*T6
3260 GOTO 3350
3270 L0=H3
3280 L1=H0
3290 L2=L0
3300 L3=.5*(L1+L2)
3310 L4=L2-L1
3320 L5=.2886751*L4
3330 T7=.5*L4*(FND(L3+L5)+FND(L3
     -L5))
3340 T(I,2)=EXP(-H(I)*T7)
3350 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY PR
     ECIPITATION.
```

```
3360 IF P=1 THEN 3390
3370 T(I,3)=1
3380 GOTO 3410
3390 IF V0>20 THEN 3370
3400 T(I,3)=EXP(-H3*R(I))
3410 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY SM
     OKE.
3420 T(I,4)=X(I)/(T(I,1)*T(I,2)*
     T(I,3))
3430 IF T(I,4)<=1 THEN 3450
3440 T(I,4)=1
3450 REM CALCULATE LINE OF SIGHT
      INTEGRATED CONCENTRATION.
3460 FOR K=1 TO 2
3470 READ D(K)
3480 NEXT K
3490 IF T(I,4)<>1 THEN 3540
3500 FOR J=1 TO 2
3510 C(I,J)=0
3520 NEXT J
3530 GOTO 3600
3540 FOR K=1 TO 2
3550 IF D(K)<>0 THEN 3580
3560 C(I,K)=0
3570 GOTO 3590
3580 C(I,K)=LOG(T(I,4))/(-D(K))
3590 NEXT K
3600 NEXT I
3610 DATA .118,26.7,.05
3620 DATA .18,7.5,.05
3630 DATA .55,5.1,.05
3640 DATA 0,5,.05
3650 DATA 3.3,2.46
3660 DATA 1.5,2
3670 DATA 0,.25
3680 DATA 0,.32
3690 REM KWIK: ATMOSPHERIC DIFFU
     SION AND SMOKE SOURCE STREN
     GTH CALCULATIONS
3700 DIM S(6,3),A(6),Q(2),H5(2,2
     ),D5(6,3),U(2,2)
3710 ! FIXED 2
3720 DISP "DIR (FR NORTH) OF LIN
     E OF SIGHT-DEG";
3730 INPUT A0
3740 PRINT USING 3750 ; A0
3750 IMAGE "DIR OF LINE OF SIGHT
       - DEG ",DDD
3760 PRINT
3770 REM ATMOSPHERIC DIFFUSION C
     ALCULATIONS.
3780 FOR I=1 TO 6
3790 READ A(I)
3800 NEXT I
3810 FOR I=1 TO 6
3820 FOR J=1 TO 3
3830 READ S(I,J)
3840 NEXT J
3850 NEXT I
```

```
3860 FOR I=1 TO 6
3870 FOR J=1 TO 3
3880 READ D5(I,J)
3890 NEXT J
3900 NEXT I
3910 READ H5(1,1),H5(1,2),H5(2,1
     ),H5(2,2)
3920 READ U(1,1),U(2,1),U(1,2),U
     (2,2)
3930 A1=-1.24+1.19*LGT(Y)
3940 Z=10^A1
3950 A2=ABS(A0-D0)*(PI/180)
3960 R2=SQR(13.69/(13.69*SIN(A2)
     *SIN(A2)+COS(A2)*COS(A2)))
3970 Y1=1.09521547+.02906894*R0-
     .00049575*R0*R0+.00000482*R
     0*R0*R0
3980 Y2=3.364059144+.060502571*R
     0-.00115301*R0*R0+.00001339
     42*R0*R0*R0
3990 C2=S(P0,1)+S(P0,2)*Z+S(P0,3
     )*Z^2
4000 D1=D5(P0,1)+D5(P0,2)*Z+D5(P
     0,3)*Z^2
4010 D2=1/D1
4020 IF S0<>0 THEN 4040
4030 S0=1
4040 S3=.515*S0
4050 DISP "SCREEN LENGTH - METER
     S";
4060 INPUT X0
4070 DISP "DURATION - MINUTES";
4080 INPUT T2
4090 FOR N=1 TO 6
4100 READ W(N)
4110 NEXT N
4120 FOR I=1 TO 4
4130 REM CALCULATE CROSSWIND INT
     EGRATED CONCENTRATION FOR W
     P SMOKE.
4140 FOR K=1 TO 2
4150 IF I<3 AND P0>4 THEN 4190
4160 S1=U(K,1)+.74*A(P0)*100^.9
4170 S2=U(K,2)+.667*C2*100^D1
4180 V(K)=W(P0)*Y2*H5(K,2)/(PI*S
     1*S2)
4190 REM MUNITION EXPENDITURES (
     HC SMOKE).
4200 REM MUNITION EFFICIENCY:
4210 Q(1)=.4
4220 Q(2)=.4
4230 REM SUSTAINING SHELL SPACIN
     G FOR HC SMOKE.
4240 IF I>2 THEN 4310
4250 IF C(I,1)<>0 THEN 4280
4260 Y(I,K)=0
4270 GOTO 4310
4280 Y(I,K)=1/R2*(.731*Q(K)*Y1*H
     5(K,1)/(C2*S3*C(I,1)))^D2
4290 IF Y(I,K)<X0 THEN 4310
```

```
4300 Y(I,K)=X0
4310 NEXT K
4320 NEXT I
4330 REM DATA USED TO CALCULATE
     SIGMA Y FOR CONTINUOUS SOUR
     CE.
4340 DATA .4,.32,.22,.144,.102,.
     076
4350 REM DATA USED TO CALCULATE
     SIGMA Z FOR CONTINUOUS SOUR
     CE.
4360 DATA .139085297,.015017284,
     -.000102581
4370 DATA .122097643,.01097037,-
     .0000680135
4380 DATA .110104377,.010962963,
     -.0000673401
4390 DATA .097649832,.010418519,
     -.0000683502
4400 DATA .070772166,.00727284,-
     .0000450056
4410 DATA .055487093,.00655309,-
     .0000401796
4420 DATA .944814815,-.00485185,
     .000037037
4430 DATA .894803591,-.00483951,
     .0000359147
4440 DATA .854792368,-.00482716,
     .0000347924
4450 DATA .816026936,-.00607407,
     .000047138
4460 DATA .786026936,-.00607407,
     000047138
4470 DATA .726015713,-.00606173,
     .0000460157
4480 REM UNIT (PER GUN) SOURCE S
     TRENGTHS.
4490 DATA 18.7,1737.3,77.1,7076.
     2
4500 REM WP VOLUME SOURCE SIGMAS
      (U(2,2)).
4510 DATA 5.4,7.9,1.8,2.6
4520 REM STABILITY CONSTANTS FOR
      WP SMOKE.
4530 DATA .016,.016,.016,.016,.0
     16,.016
4540 REM KWIK: MUNITION EXPENDIT
     URES (CONTINUATION).
4550 DIM R5(4,2),I(4,2),J(4,2),P
     5(4,2),E(4,2),F(4,2),G5(4,2
     ),Q9(4,2),L(4,2)
4560 DIM A$[8]
4570 ! FIXED 2
4580 S3=S0*.515
4590 REM UNIT SOURCE STRENGTH.
4600 READ H5(1,1),H5(1,2),H5(2,1
     ),H5(2,2)
4610 FOR I=1 TO 4
4620 FOR K=1 TO 2
4630 IF I>2 THEN 4950
```

```
4640 REM CALCULATE INITIAL SHELL
      SPACING FOR HC SMOKE.
4650 I(I,K)=S3*45
4660 IF Y(I,K)<>0 THEN 4700
4670 E(I,K)=1
4680 F(I,K)=1
4690 GOTO 4850
4700 REM CALCULATE INITIAL VOLEY
      FOR HC SMOKE.
4710 IF I(I,K)>Y(I,K) THEN 4730
4720 GOTO 4740
4730 I(I,K)=Y(I,K)
4740 E(I,K)=X0/I(I,K)
4750 Q5=INT(E(I,K))
4760 Q6=E(I,K)-Q5
4770 IF Q6=0 THEN 4790
4780 E(I,K)=Q5+1
4790 REM CALCULATE NUMBER OF GUN
      S FOR SUSTAINING VOLLEYS (H
      C SMOKE).
4800 F(I,K)=X0/Y(I,K)
4810 Q5=INT(F(I,K))
4820 Q6=F(I,K)-Q5
4830 IF Q6=0 THEN 4850
4840 F(I,K)=Q5+1
4850 REM CALCULATE RATE OF FIRE
      OR HC SMOKE.
4860 R1=.5
4870 IF C(I,1)<>0 THEN 4890
4880 R1=0
4890 REM CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (HC SMOK
      E).
4900 J(I,K)=E(I,K)+(R1*T2-1)*F(I
      ,K)
4910 Q5=INT(J(I,K))
4920 Q6=J(I,K)-Q5
4930 IF Q6=0 THEN 4950
4940 J(I,K)=Q5+1
4950 IF I<3 AND P0>4 THEN 5480
4960 REM SHELL SPACING (L( ) & Z
      ( )) & VOLLEYS (G( ) & Q( )
      ) - WP SMOKE.
4970 IF C(I,2)<>0 THEN 5020
4980 Z(I,K)=0
4990 G5(I,K)=0
5000 Q9(I,K)=0
5010 GOTO 5170
5020 IF I>2 THEN 5090
5030 L(I,K)=V(K)/C(I,2)*100
5040 IF L(I,K)<=X0 THEN 5060
5050 L(I,K)=X0
5060 Z(I,K)=L(I,K)
5070 G5(I,K)=X0/Z(I,K)
5080 GOTO 5100
5090 G5(I,K)=.6*C(I,2)/V(K)
5100 Q5=INT(G5(I,K))
5110 Q6=G5(I,K)-Q5
5120 IF Q6=0 THEN 5150
5130 G5(I,K)=Q5+1
```

```
5140 GOTO 5160
5150 G5(I,K)=Q5
5160 Q9(I,K)=G5(I,K)
5170 REM RATE OF FIRE FOR WF SMO
     KE.
5180 IF C(I,2)<>0 THEN 5210
5190 R5(I,K)=0
5200 GOTO 5350
5210 IF I>2 THEN 5240
5220 R5(I,K)=(Z(I,K)+60)/S3
5230 GOTO 5250
5240 R5(I,K)=120/S3
5250 R5(I,K)=R5(I,K)/20
5260 R5=INT(R5(I,K))
5270 R6=R5(I,K)-R5
5280 IF R6<.5 THEN 5300
5290 R5=R5+1
5300 IF R5<>0 THEN 5320
5310 R5=1
5320 R5(I,K)=R5*20/60
5330 R5(I,K)=1/R5(I,K)
5340 IF R5(I,K)<1 THEN R5(I,K)=1
5350 REM CALCULATE TOTAL NUMBER
     OF ROUNDS REQUIRED (WP SMOK
     E)
5360 IF C(I,2)<>0 THEN 5390
5370 P5(I,K)=0
5380 GOTO 5810
5390 IF I>2 THEN 5420
5400 P5(I,K)=G5(I,K)+Q9(I,K)*(T2
     *R5(I,K)-1)
5410 GOTO 5430
5420 P5(I,K)=Q9(I,K)*(X0/60+1)*(
     T2*R5(I,K)-1)
5430 Q5=INT(P5(I,K))
5440 Q6=P5(I,K)-Q5
5450 IF Q6=0 THEN 5470
5460 P5(I,K)=Q5+1
5470 GOTO 5810
5480 REM CALCULATIONS FOR WP SMO
     KE E & F STABILITY CATEGORI
     ES (STABLE FLOW).
5490 REM INITIAL SHELL SPACING
5500 IF I=1 AND K=1 THEN 5530
5510 IF I<7 AND K=2 THEN 5530
5520 IF I=2 AND K=1 THEN 5550
5530 L(I,K)=100
5540 GOTO 5560
5550 L(I,K)=50
5560 REM SUSTAINING SHELL SPACIN
     G
5570 IF I=1 AND K=1 THEN 5610
5580 IF I=2 AND K=2 THEN 5610
5590 IF I=1 AND K=2 THEN 5630
5600 IF I=2 AND K=1 THEN 5650
5610 Z(I,K)=100
5620 GOTO 5660
5630 Z(I,K)=200
5640 GOTO 5660
5650 Z(I,K)=50
```

```
5660 REM INITIAL VOLLEY - WP SMO
     KE.
5670 G5(I,K)=X0/L(I,K)+1
5680 REM SUSTAINING VOLLEY.
5690 Q9(I,K)=X0/Z(I,K)+1
5700 REM RATE OF FIRE - WP SMOKE
     .
5710 IF K=1 THEN 5730
5720 IF K=2 THEN 5750
5730 R5(I,K)=2
5740 GOTO 5760
5750 R5(I,K)=1
5760 REM TOTAL NUMBER OF WP ROUN
     DS REQUIRED.
5770 P5(I,K)=G5(I,K)+Q9(I,K)*(T2
     *R5(I,K)-1)
5780 Q5=INT(P5(I,K))
5790 Q6=P5(I,K)-Q5
5800 IF Q6>0 THEN P5(I,K)=Q5+1
5810 NEXT K
5820 NEXT I
5830 FOR I=1 TO 4
5840 PRINT
5850 PRINT
5860 PRINT
5870 PRINT
5880 PRINT
5890 PRINT
5900 READ A$
5910 PRINT "                  ";A$
5920 PRINT
5930 PRINT
5940 PRINT "
       METERS MIN"
5950 PRINT USING 5960 ; X0,T2
5960 IMAGE "SCREEN LENGTH/DURATI
     ON:",DDDDD,1X,DDD
5970 PRINT
5980 PRINT
5990 IF I>2 THEN 6500
6000 PRINT "            HC SMOKE SC
     REEN"
6010 PRINT
6020 PRINT
6030 PRINT "           105MM HOWIT
     ZER"
6040 PRINT
6050 PRINT "VOLLEY GUNS RATE/ SP
     ACING ROUNDS"
6060 PRINT "                MIN    M
     ETERS"
6070 PRINT USING 6080 ; E(I,1),I
     (I,1)
6080 IMAGE "INITIAL:",DDD,7X,DDD
     DDDD
6090 PRINT USING 6100 ; F(I,1),R
     1,Y(I,1),J(I,1)
6100 IMAGE "SUSTAIN:",DDD,1X,DD.
     D,2X,DDDDDDD,1X,DDDDDD
6110 PRINT
```

```
6120 PRINT
6130 PRINT
6140 PRINT "           155MM HOWIT
     ZER"
6150 PRINT
6160 PRINT "VOLLEY GUNS RATE/ SP
     ACING ROUNDS"
6170 PRINT "                 MIN   M
     ETERS"
6180 PRINT USING 6190 ; E(I,2),I
     (I,2)
6190 IMAGE "INITIAL:",DDD,7X,DDD
     DDDD
6200 PRINT USING 6210 ; F(I,2),R
     1,Y(I,2),J(I,2)
6210 IMAGE "SUSTAIN:",DDD,1X,DD.
     D,2X,DDDDDDD,1X,DDDDDD
6220 PRINT
6230 PRINT
6240 PRINT
6250 PRINT "           WP SMOKE SC
     REEN"
6260 PRINT
6270 PRINT
6280 PRINT "           105MM HOWIT
     ZER"
6290 PRINT
6300 PRINT "VOLLEY GUNS RATE/ SP
     ACING ROUNDS"
6310 PRINT "                 MIN   M
     ETERS"
6320 PRINT USING 6330 ; G5(I,1),
     L(I,1)
6330 IMAGE "INITIAL:",DDD,7X,DDD
     DDDD
6340 PRINT USING 6350 ; Q9(I,1),
     R5(I,1),Z(I,1),P5(I,1)
6350 IMAGE "SUSTAIN:",DDD,1X,DD.
     D,2X,DDDDDDD,1X,DDDDDD
6360 PRINT
6370 PRINT
6380 PRINT
6390 PRINT "           155MM HOWIT
     ZER"
6400 PRINT
6410 PRINT "VOLLEY GUNS RATE/ SP
     ACING ROUNDS"
6420 PRINT "                 MIN   M
     ETERS"
6430 PRINT USING [illegible]40 ; G5(I,2),
     L(I,2)
6440 IMAGE "INITIAL ",DDD,7X,DDD
     DDDD
6450 PRINT USING 64[illegible] ; Q9(I,2),
     R[illegible]I,2),Z(I,2),[illegible]5(I,2)
[illegible]E "SUSTAIN:",DDD,1X,DD.
     [illegible],DDDDDDD,1X,DDDDDD
6470 PRINT
6480 PRINT
6490 IF I[illegible]3 THEN 6590
```

```
6500 PRINT "          WP SMOKE SC
     REEN"
6510 PRINT
6520 PRINT
6530 PRINT "          ROUNDS/   RA
     TE/   TOTAL"
6540 PRINT "         60 METERS MI
     NUTE ROUNDS"
6550 PRINT USING 6560 ; Q9(I,1),
     R5(I,1),P5(I,1)
6560 IMAGE "105MM:   ",DDDDDD,4X,
     DDD,4X,DDDDD
6570 PRINT USING 6580 ; Q9(I,2),
     R5(I,2),P5(I,2)
6580 IMAGE "155MM:   ",DDDDDD ,4X
     ,DDD ,4X,DDDDD
6590 NEXT I
6600 PRINT
6610 PRINT
6620 PRINT
6630 PRINT
6640 PRINT
6650 PRINT
6660 PRINTER IS 1
6670 DISP "DONE"
6680 REM UNIT (PER GUN) SOURCE S
     TRENGTHS.
6690 DATA 18.7,1737.3,77.1,7076.
     2
6700 DATA "VISIBLE:"
6710 DATA "NEAR IR:"
6720 DATA "MID IR:"
6730 DATA "FAR IR:"
6740 END
```

APPENDIX K

HP 9845 (BASIC) ALGORITHM

```
10    REM KWIK SMOKE ALGORITHM (HP 9845) SEPTEMBER 23, 1981
20    REM KWIK: METEOROLOGICAL INPUTS AND METEOROLOGICAL CALCULATIONS.
30    OPTION BASE 1
40    PRINTER IS 0
50    DIM C(4,2),T(4,4),V(2),W(6),Y(4,2),Z(4,2)
60    DIM S(6,3),A(6),Q(2),H5(2,2),D5(6,3),U(2,2)
70    DIM R5(4,2),I(4,2),J(4,2),P5(4,2),E(4,2),F(4,2),G5(4,2),Q9(4,2),L(4,2)
80    DIM B(4),G(4),H(4),R(4),D(2),X(4)
90    DIM I$[4],P(7,9),Q$[6],H$[1],J$[1]
100   DIM A$[8]
110   FIXED 2
120   PRINT
130   PRINT
140   PRINT "                                        MUNITION EXPENDITURES"
150   PRINT "                                         FOR HC AND WP SMOKE"
160   PRINT
170   PRINT
180   DISP "MET SITE ID";
190   INPUT I$
200   DISP "LATITUDE OF MET SITE- DEG";
210   INPUT L0
220   REM "DIRECTION FROM EQUATOR- N OR S":
230   H$="N"
240   DISP "LONGITUDE OF MET SITE - DEG";
250   INPUT L1
260   DISP "DIRECTION FROM GREENWICH- E OR W";
270   INPUT J$
280   DISP "JULIAN DATE OF MET OBSERVATION";
290   INPUT J0
300   DISP "ZULU TIME OF MET OSERVATION-HR";
310   INPUT H0
320   DISP "CEILING - FEET";
330   INPUT C0
340   C0=C0*.3048
350   DISP "CLOUD COVER - PERCENT";
360   INPUT C1
370   DISP "VISIBILITY - MILES";
380   INPUT V0
390   V0=V0*1.61
400   DISP "PRECIPITATION - 1=YES 0=NO";
410   INPUT P
420   DISP "TEMPERATURE - DEG F";
430   INPUT T0
440   T0=5/9*(T0-32)
450   DISP "DEW POINT - DEG F";
460   INPUT T1
470   T1=5/9*(T1-32)
480   DISP "WIND DIRECTION - DEGS";
490   INPUT D0
500   DISP "WIND SPEED KNOTS";
```

```
510    INPUT S0
520    DISP "AVE ROUGHNESS ELEMENT - CM";
530    INPUT Y
540    DISP "SLANT RANGE TO TARGET - KM";
550    INPUT H3
560    DISP "ANGLE OF SIGHT TO TARGET - DEG";
570    INPUT S
580    DISP "DIRECTION OF LINE OF SIGHT-DEG";
590    INPUT A9
600    DISP "SCREEN LENGTH - METERS";
610    INPUT X0
620    DISP "DURATION - MINUTES";
630    INPUT T2
640    PRINT "                      ID                                     =  ";I$
650    PRINT "                      LATITUDE                 - DEG         = ";H$[1];L0
660    PRINT "                      LONGITUDE                - DEG         = ";J$[1];L1
670    PRINT "                      JULIAN DATE              - DAY         = ";J0
680    PRINT "                      ZULU TIME                - HOUR        = ";H0
690    PRINT "                      CEILING                  - METERS      = ";C0
700    PRINT "                      CLOUD COVER              - PERCENT     = ";C1
710    PRINT "                      VISIBILITY               - KILOMETERS  = ";V0
720    PRINT "                      PRECIPITATION                          = ";P
730    PRINT "                      TEMPERATURE              - DEG C       = ";T0
740    PRINT "                      DEW POINT                - DEG C       = ";T1
750    PRINT "                      WIND DIRECTION           - DEG         = ";D0
760    PRINT "                      WIND SPEED               - KNOTS       = ";S0
770    PRINT "                      AVE ROUGHNESS ELEMENT    - CM          = ";Y
780    FOR J=1 TO 9
790    FOR I=1 TO 7
800    READ P(I,J)
810    NEXT I
820    NEXT J
830    READ Q$
840    IF J$<>"E" THEN 870
850    L1=-L1
860    REM MET CALCULATIONS.
870    IF C1<>100 THEN 920
880    IF C0>2133.6042 THEN 920
890    I1=0
900    I2=0
910    GOTO 1530
920    REM CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE (A0)
930    R9=PI/180
940    D9=180/PI
950    L0=L0*R9
960    A0=(J0-1)*360/365.242
970    REM CALCULATE SOLAR DECLINATION ANGLE (A4).
980    A1=A0*R9
990    A2=279.9348+A0
1000   A2=A2+1.914827*SIN(A1)-.079525*COS(A1)
```

```
1010  A2=A2+.019938*SIN(2*A1)-.00162*COS(2*A1)
1020  A2=A2*R9
1030  A3=23.4438*R9
1040  A4=SIN(A3)*SIN(A2)
1050  A4=ATN(A4/SQR(1-A4*A4+1E-99))
1060  REM CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
1070  A5=12+.12357*SIN(A1)-.004289*COS(A1)
1080  A5=A5+.153809*SIN(2*A1)+.060783*COS(2*A1)
1090  REM CALCULATE SOLAR HOUR ANGLE (A6)
1100  A6=15*(H0-A5)-L1
1110  A6=A6*R9
1120  REM CALCULATE SOLAR ALTITUDE (A7)
1130  A7=SIN(L0)*SIN(A4)+COS(L0)*COS(A4)*COS(A6)
1140  A7=ATN(A7/SQR(1-A7*A7+1E-99))
1150  A7=A7*D9
1160  REM CALCULATE INSOLATION CLASS NUMBER.
1170  I2=0
1180  IF A7<=60 THEN 1210
1190  I2=4
1200  GOTO 1290
1210  IF A7<=35 THEN 1240
1220  I2=3
1230  GOTO 1290
1240  IF A7<=15 THEN 1270
1250  I2=2
1260  GOTO 1290
1270  IF A7<=0 THEN 1480
1280  I2=1
1290  REM CALCULATE NET RADIATION INDEX FOR DAYTIME.
1300  I3=0
1310  IF C1>50 THEN 1340
1320  I3=I2
1330  GOTO 1420
1340  IF C0>=2133.6042 THEN 1370
1350  I3=I2-2
1360  GOTO 1420
1370  IF C0>=4876.8096 THEN 1400
1380  I3=I2-1
1390  GOTO 1420
1400  IF C1<>100 THEN 1420
1410  I3=I2-1
1420  IF I3<>0 THEN 1440
1430  I3=I2
1440  IF I3>1 THEN 1460
1450  I3=1
1460  I1=I3
1470  GOTO 1530
1480  REM CALCULATE NET RADIATION INDEX FOR NIGHTTIME
1490  IF C1>40 THEN 1520
1500  I1=-2
```

```
1510  GOTO 1530
1520  I1=-1
1530  REM CALCULATE PASQUILL STABILITY CATEGORY.
1540  I4=0
1550  I5=0
1560  IF I1<>4 THEN 1580
1570  I4=1
1580  IF I1<>3 THEN 1600
1590  I4=2
1600  IF I1<>2 THEN 1620
1610  I4=3
1620  IF I1<>1 THEN 1640
1630  I4=4
1640  IF I1<>0 THEN 1660
1650  I4=5
1660  IF I1<>-1 THEN 1680
1670  I4=6
1680  IF I1<>-2 THEN 1700
1690  I4=7
1700  IF S0>=2 THEN 1730
1710  I5=1
1720  GOTO 1950
1730  IF S0>=4 THEN 1760
1740  I5=2
1750  GOTO 1950
1760  IF S0>=6 THEN 1790
1770  I5=3
1780  GOTO 1950
1790  IF S0>=7 THEN 1820
1800  I5=4
1810  GOTO 1950
1820  IF S0>=8 THEN 1850
1830  I5=5
1840  GOTO 1950
1850  IF S0>=10 THEN 1880
1860  I5=6
1870  GOTO 1950
1880  IF S0>=11 THEN 1910
1890  I5=7
1900  GOTO 1950
1910  IF S0>=12 THEN 1940
1920  I5=8
1930  GOTO 1950
1940  I5=9
1950  P0=P(I4,I5)
1960  REM CALCULATE RELATIVE HUMIDITY
1970  IF T0>0 THEN 2010
1980  A0=9.5
1990  B0=265.5
2000  GOTO 2030
```

```
2010  A0=7.5
2020  B0=237.3
2030  IF T1>0 THEN 2070
2040  A1=9.5
2050  B1=265.5
2060  GOTO 2090
2070  A1=7.5
2080  B1=237.3
2090  E0=6.11*10^(A0*T0/(B0+T0))
2100  E1=6.11*10^(A1*T1/(B1+T1))
2110  R0=E1/E0*100
2120  PRINT "                        PASQUILL STABILITY CATEGORY          =  ";Q$[P0,P0]
2130  PRINT "                        RELATIVE HUMIDITY                    = ";R0
2140  PRINT
2150  PRINT
2160  REM KWIK: ATMOSPHERIC OPTICS AND SMOKE CONCENTRATION CALCULATIONS.
2170  FOR I=1 TO 4
2180  READ B(I),G(I),X(I)
2190  NEXT I
2200  V1=LOG(V0)
2210  V2=V1*V1
2220  V3=V2*V1
2230  H(i)=1.5551-.9811*V1-.0197*V2+.0041*V3
2240  H(1)=EXP(H(1))
2250  H(2)=1.50381511-.992319519*V1-.015972801*V2+.00368583*V3
2260  H(2)=EXP(H(2))
2270  H(3)=1.2394-1.0436*V1+.0099*V2-.0016*V3
2280  H(3)=EXP(H(3))
2290  H(4)=1.5176-1.7147*V1+.0001*V2+.0428*V3
2300  H(4)=EXP(H(4))
2310  R(1)=1.3306-.8825*V1-.0753*V2+.0129*V3
2320  R(1)=EXP(R(1))
2330  R(2)=1.481951707-.922595829*V1-.065509417*V2+.013680422*V3
2340  R(2)=EXP(R(2))
2350  R(3)=1.5556-.9013*V1-.0773*V2+.0173*V3
2360  R(3)=EXP(R(3))
2370  R(4)=1.5928-.9396*V1-.0627*V2+.0168*V3
2380  R(4)=EXP(R(4))
2390  H0=0
2400  IF S>=0 THEN 2420
2410  S=-S
2420  S=S*(PI/180)
2430  S=SIN(S)
2440  H4=0
2450  IF S=0 THEN 2480
2460  H4=1/S
2470  REM CALCULATE PRECIPITABLE WATER.
2480  W=.4477+.0328*T1+1.2E-3*T1*T1+1.84E-5*T1*T1*T1
2490  REM CALCULATE AMOUNT OF WATER IN PATH.
2500  DEF FNA(A)=EXP(-S*A/2)
```

```
2510  L0=H3
2520  L1=H0
2530  L2=L0
2540  L3=.5*(L1+L2)
2550  L4=L2-L1
2560  L5=.2886751*L4
2570  W0=.5*L4*(FNA(L3+L5)+FNA(L3-L5))
2580  W1=W*W0
2590  REM CALCULATE TRANSMITTANCES FOR VISUAL, NEAR, MID AND FAR IR WAVELENGTI
2600  FOR I=1 TO 4
2610  REM CALCULATE TRANSMITTANCES OWING TO ABSORPTION BY WATER VAPOR.
2620  IF I<>4 THEN 2650
2630  T(I,1)=EXP(-.0681*W1)
2640  GOTO 2750
2650  DEF FNB(B)=EXP(-B^2)
2660  L0=B(I)*SQR(W1*PI)/2
2670  L1=H0
2680  L2=L0
2690  L3=.5*(L1+L2)
2700  L4=L2-L1
2710  L5=.2886751*L4
2720  M2=.5*L4*(FNB(L3+L5)+FNB(L3-L5))
2730  T(I,1)=2/SQR(PI)*M2
2740  T(I,1)=1-T(I,1)
2750  REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
2760  IF P=0 THEN 2790
2770  T(I,2)=1
2780  GOTO 3070
2790  IF V0>=G(I) THEN 2990
2800  DEF FNC(C)=EXP(C*S*LOG(.1/H(I)))
2810  L0=H4
2820  L1=H0
2830  L2=L0
2840  L3=.5*(L1+L2)
2850  L4=L2-L1
2860  L5=.2886751*L4
2870  T3=   .5*L4*(FNC(L3+L5)+FNC(L3-L5))
2880  T4=EXP(-H(I)*T3)
2890  DEF FND(D)=EXP(-D*S/4.1)
2900  L1=H4
2910  L2=H3
2920  L3=.5*(L1+L2)
2930  L4=L2-L1
2940  L5=.2886751*L4
2950  T5=.5*L4*(FND(L3+L5)+FND(L3-L5))
2960  T6=EXP(-.128*T5)
2970  T(I,2)=T4*T6
2980  GOTO 3070
2990  L0=H3
3000  L1=H0
```

```
3010 L2=L0
3020 L3=.5*(L1+L2)
3030 L4=L2-L1
3040 L5=.2886741*L4
3050 T7=.5*L4*(FND(L3+L5)+FND(L3-L5))
3060 T(I,2)=EXP(-H(I)*T7)
3070 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
3080 IF P=1 THEN 3110
3090 T(I,3)=1
3100 GOTO 3130
3110 IF V0>20 THEN 3090
3120 T(I,3)=EXP(-H3*R(I))
3130 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
3140 T(I,4)=X(I)/(T(I,1)*T(I,2)*T(I,3))
3150 IF T(I,4)<=1 THEN 3170
3160 T(I,4)=1
3170 REM CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
3180 FOR K=1 TO 2
3190 READ D(K)
3200 NEXT K
3210 IF T(I,4)<>1 THEN 3260
3220 FOR J=1 TO 2
3230 C(I,J)=0
3240 NEXT J
3250 GOTO 3320
3260 FOR K=1 TO 2
3270 IF D(K)<>0 THEN 3300
3280 C(I,K)=0
3290 GOTO 3310
3300 C(I,K)=LOG(T(I,4))/-D(K)
3310 NEXT K
3320 NEXT I
3330 REM ATMOSPHERIC DIFFUSION CALCULATIONS.
3340 FOR L=1 TO 6
3350 READ A(L)
3360 NEXT L
3370 FOR I=1 TO 6
3380 FOR J=1 TO 3
3390 READ S(I,J)
3400 NEXT J
3410 NEXT I
3420 FOR I=1 TO 6
3430 FOR J=1 TO 3
3440 READ D5(I,J)
3450 NEXT J
3460 NEXT I
3470 READ H5(1,1),H5(1,2),H5(2,1),H5(2,2)
3480 READ U(1,1),U(2,1),U(1,2),U(2,2)
3490 A1=-1.24+1.19*LGT(Y)
3500 Z=10^A1
```

```
3510  A2=ABS(A9-D0)*(PI/180)
3520  R2=SQR(13.69/(13.69*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
3530  Y1=1.09521547+.02906894*R0-4.9575E-4*R0*R0+4.82E-6*R0*R0*R0
3540  Y2=3.364059144+.060502571*R0-1.15301E-3*R0*R0+1.33942E-5*R0*R0*R0
3550  C2=S(P0,1)+S(P0,2)*Z+S(P0,3)*Z^2
3560  D1=D5(P0,1)+D5(P0,2)*Z+D5(P0,3)*Z^2
3570  D2=1/D1
3580  IF S0<>0 THEN 3600
3590  S0=1
3600  S3=.515*S0
3610  FOR N=1 TO 6
3620  READ W(N)
3630  NEXT N
3640  FOR I=1 TO 4
3650  REM CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
3660  FOR K=1 TO 2
3670  IF (I<3) AND (P0>4) THEN 3710
3680  S1=U(K,1)+.74*A(P0)*100^.9
3690  S2=U(K,2)+.667*C2*100^D1
3700  V(K)=W(P0)*Y2*H5(K,2)/(PI*S1*S2)
3710  REM MUNITION EXPENDITURES (HC SMOKE).
3720  Q(1)=Q(2)=.4  ! MUNITION EFICIENCIES
3730  REM SUSTAINING SHELL SPACING FOR HC SMOKE.
3740  IF I>2 THEN 3810
3750  IF C(I,1)<>0 THEN 3780
3760  Y(I,K)=0
3770  GOTO 3810
3780  Y(I,K)=1/R2*(.731*Q(K)*Y1*H5(K,1)/(C2*S3*C(I,1)))^D2
3790  IF Y(I,K)<X0 THEN 3810
3800  Y(I,K)=X0
3810  NEXT K
3820  NEXT I
3830  FOR I=1 TO 4
3840  FOR K=1 TO 2
3850  IF I>2 THEN 4170
3860  REM CALCULATE INITIAL SHELL SPACING FOR HC SMOKE.
3870  I(I,K)=S3*45
3880  IF Y(I,K)<>0 THEN 3920
3890  E(I,K)=1
3900  F(I,K)=1
3910  GOTO 4070
3920  REM CALCULATE INITIAL VOLLEY FOR HC SMOKE.
3930  IF I(I,K)>Y(I,K) THEN 3950
3940  GOTO 3960
3950  I(I,K)=Y(I,K)
3960  E(I,K)=X0/I(I,K)
3970  Q5=INT(E(I,K))
3980  Q6=E(I,K)-Q5
3990  IF Q6=0 THEN 4010
4000  E(I,K)=Q5+1
```

```
4010  REM CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC SMOKE).
4020  F(I,K)=X0/Y(I,K)
4030  Q5=INT(F(I,K))
4040  Q6=F(I,K)-Q5
4050  IF Q6=0 THEN 4070
4060  F(I,K)=Q5+1
4070  R1=.5           ! RATE OF FIRE FOR HC SMOKE
4080  IF C(I,1)<>0 THEN 4100
4090  R1=0
4100  REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE).
4110 ! J(I,K)=E(I,K)+1/2*F(I,K)*(T2-2)% CHANGE COORDINATED WITH PENA ON 19MAY81
4120  J(I,K)=E(I,K)+(R1*T2-1)*F(I,K) !% THIS LINE REPLACES THE LINE ABOVE IT %.
4130  Q5=INT(J(I,K))
4140  Q6=J(I,K)-Q5
4150  IF Q6=0 THEN 4170
4160  J(I,K)=Q5+1
4170  IF (I<3) AND (P0>4) THEN 4700
4180  REM SHELL SPACING (L( ) & Z( )) & VOLLEYS (G( ) & Q( )) - WP SMOKE.
4190  IF C(I,2)<>0 THEN 4240
4200  Z(I,K)=0
4210  G5(I,K)=0
4220  Q9(I,K)=0
4230  GOTO 4390
4240  IF I>2 THEN 4310
4250  L(I,K)=V(K)/C(I,2)*100
4260  IF L(I,K)<X0 THEN 4280
4270  L(I,K)=X0
4280  Z(I,K)=L(I,K)
4290  G5(I,K)=X0/Z(I,K)
4300  GOTO 4320
4310  G5(I,K)=.6*C(I,2)/V(K)
4320  Q5=INT(G5(I,K))
4330  Q6=G5(I,K)-Q5
4340  IF Q6=0 THEN 4370
4350  G5(I,K)=Q5+1
4360  GOTO 4380
4370  G5(I,K)=Q5
4380  Q9(I,K)=G5(I,K)
4390  REM RATE OF FIRE FOR WP SMOKE.
4400  IF C(I,2)<>0 THEN 4430
4410  R5(I,K)=0
4420  GOTO 4570
4430  IF I>2 THEN 4460
4440  R5(I,K)=(Z(I,K)+60)/S3
4450  GOTO 4470
4460  R5(I,K)=120/S3
4470  R5(I,K)=R5(I,K)/20
4480  R5=INT(R5(I,K))
4490  R6=R5(I,K)-R5
4500  IF R6<.5 THEN 4520
```

```
4510  R5=R5+1
4520  IF R5<>0 THEN 4540
4530  R5=1
4540  R5(I,K)=R5*20/60
4550  R5(I,K)=1/R5(I,K)
4560  IF R5(I,K)<1 THEN R5(I,K)=1
4570  REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP SMOKE)
4580  IF C(I,2)<>0 THEN 4610
4590  P5(I,K)=0
4600  GOTO 5010
4610  IF I>2 THEN 4640
4620  P5(I,K)=(T2*R5(I,K)-1)*Q9(I,K)+G5(I,K)
4630  GOTO 4650
4640  P5(I,K)=Q9(I,K)*(X0/60+1)*(T2*R5(I,K)-1)
4650  Q5=INT(P5(I,K))
4660  Q6=P5(I,K)-Q5
4670  IF Q6=0 THEN 4690
4680  P5(I,K)=Q5+1
4690  GOTO 5000
4700  REM CALCULATIONS FOR WP SMOKE E & F STABILITY CATEGORIES (STABLE FLOW
4710  REM INITIAL SHELL SPACING
4720  IF (I=1) AND (K=1) THEN 4750
4730  IF (I<3) AND (K=2) THEN 4750
4740  IF (I=2) AND (K=1) THEN 4770
4750  L(I,K)=100
4760  GOTO 4780
4770  L(I,K)=50
4780  REM SUSTAINING SHELL SPACING
4790  IF (I=1) AND (K=1) THEN 4830
4800  IF (I=2) AND (K=2) THEN 4830
4810  IF (I=1) AND (K=2) THEN 4850
4820  IF (I=2) AND (K=1) THEN 4870
4830  Z(I,K)=100
4840  GOTO 4880
4850  Z(I,K)=200
4860  GOTO 4880
4870  Z(I,K)=50
4880  REM INITIAL VOLLEY - WP SMOKE.
4890  G5(I,K)=X0/L(I,K)+1
4900  REM SUSTAINING VOLLEY.
4910  Q9(I,K)=X0/Z(I,K)+1
4920  REM RATE OF FIRE - WP SMOKE.
4930  IF K=1 THEN 4950
4940  IF K=2 THEN 4970
4950  R5(I,K)=2
4960  GOTO 4980
4970  R5(I,K)=1
4980  REM TOTAL NUMBER OF WP ROUNDS REQUIRED.
4990  P5(I,K)=(T2*R5(I,K)-1)*Q9(I,K)+G5(I,K)
5000  NEXT K
```

```
5010  NEXT I
5020  FOR I=1 TO 4
5030  PRINT LIN(7)
5040  READ A$
5050  PRINT "                                        ";A$
5060  PRINT LIN(2)
5070  PRINT "                                                        METERS MINUTES"
5080  PRINT USING 5090;X0,T2
5090  IMAGE "                    SCREEN LENGTH/DURATION: ",DDDDD.,4X,DD.
5100  PRINT LIN(2)
5110  IF I>2 THEN 5530
5120  PRINT "                               HC SMOKE SCREEN"
5130  PRINT LIN(2)
5140  PRINT "                               105MM HOWITZER"
5150  PRINT LIN(1)
5160  PRINT "                    VOLLEY     GUNS RATE/ SPACING ROUNDS"
5170  PRINT "                                     MIN   METERS"
5180  PRINT USING 5190;E(I,1),I(I,1)
5190  IMAGE "                    INITIAL:     ",DDD,11X,DDD
5200  PRINT USING 5210;F(I,1),R1,Y(I,1),J(I,1)
5210  IMAGE "                    SUSTAINING:",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5220  PRINT LIN(3)
5230  PRINT "                               155MM HOWITZER"
5240  PRINT LIN(1)
5250  PRINT "                    VOLLEY     GUNS RATE/ SPACING ROUNDS"
5260  PRINT "                                     MIN    METERS"
5270  PRINT USING 5190;E(I,2),I(I,2)
5280  IMAGE "                    INITIAL:      ",DDD,10X,DDDD
5290  PRINT USING 5210;F(I,2),R1,Y(I,2),J(I,2)
5300  IMAGE "                    SUSTAINING:",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5310  PRINT LIN(3)
5320  PRINT "                               WP SMOKE SCREEN"
5330  PRINT LIN(2)
5340  PRINT "                               105MM HOWITZER"
5350  PRINT LIN(1)
5360  PRINT "                    VOLLEY     GUNS RATE/ SPACING ROUNDS"
5370  PRINT "                                     MIN METERS"
5380  PRINT USING 5190;G5(I,1),L(I,1)
5390  IMAGE "                    INITIAL:",DDD,10X,DDDD
5400  PRINT USING 5300;Q9(I,1),R5(I,1),Z(I,1),P5(I,1)
5410  IMAGE "                    SUSTAINING:",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5420  PRINT LIN(3)
5430  PRINT "                              155MM HOWITZER"
5440  PRINT LIN(1)
5450  PRINT "                    VOLLEY    GUNS RATE/ SPACING ROUNDS"
5460  PRINT "                                    MIN   METERS"
5470  PRINT USING 5190;G5(I,2),L(I,2)
5480  IMAGE "                    INITIAL:",DDD,10X,DDDD
5490  PRINT USING 5300;Q9(I,2),R5(I,2),Z(I,2),P5(I,2)
5500  IMAGE "                    SUSTAINING:",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
```

```
5510  PRINT LIN(2)
5520  IF I<3 THEN 5610
5530  PRINT "                              WP SMOKE SCREEN"
5540  PRINT LIN(2)
5550  PRINT "                           ROUNDS/     RATE/     TOTAL"
5560  PRINT "                          60 METERS   MINUTE    ROUNDS"
5570  PRINT USING 5580;Q9(I,1),R5(I,1),P5(I,1)
5580  IMAGE "                 105MM:   ",DDDDD.,5X,DDD.,5X,DDDDDDD.
5590  PRINT USING 5600;Q9(I,2),R5(I,2),P5(I,2)
5600  IMAGE "                 155MM:   ",DDDDD.,5X,DDD.,5X,DDDDDDD.
5610  NEXT I
5620  PRINT LIN(6)
5630  PRINTER IS 16
5640  DISP "DONE"
5650  REM PASQUILL STABILITY CATEGORY DATA
5660  DATA 1,1,2,3,4,6,6
5670  DATA 1,2,2,3,4,6,6
5680  DATA 1,2,3,4,4,5,6
5690  DATA 2,2,3,4,4,5,6
5700  DATA 2,2,3,4,4,4,5
5710  DATA 2,3,3,4,4,4,5
5720  DATA 3,3,4,4,4,4,5
5730  DATA 3,3,4,4,4,4,4
5740  DATA 3,4,4,4,4,4,4
5750  DATA "ABCDEF"
5760  REM ABSORPTION COEFICIENT,SCALE HEIGHT AND WAVELENGTH THRESHOLD.
5770  DATA 0.118,26.7,0.05
5780  DATA 0.18,7.5,0.05
5790  DATA 0.55,5.1,0.05
5800  DATA 0,5,0.05
5810  REM EXTINCTION COEFICIENTS FOR HC AND WP.
5820  DATA 3.3,2.46
5830  DATA 1.5,2
5840  DATA 0,0.25
5850  DATA 0, 0.32
5860  REM DATA USED TO CALCULATE SIGMA Y FOR CONTINUOUS SOURCE.
5870  DATA 0.4,0.32,0.22,0.144,0.102,0.076
5880  REM DATA USED TO CALCULATE SIGMA Z FOR CONTINUOUS SOURCE.
5890  DATA 0.139085297,0.015017284,-1.02581E-04
5900  DATA 0.122097643,0.01097037,-6.80135E-05
5910  DATA 0.110104377,0.010962963,-6.73401E-05
5920  DATA 0.097649832,0.010418519,-6.83502E-05
5930  DATA 0.070772166,7.27284E-03,-4.50056E-05
5940  DATA 0.055487093, 6.55309E-03,-4.01796E-05
5950  DATA 0.944814815,-4.85185E-03,3.7037E-05
5960  DATA 0.894803591,-4.83951E-03,3.59147E-05
5970  DATA 0.854792368,-4.82716E-03,3.47924E-05
5980  DATA 0.816026936, -6.07407E-03,4.7138E-05
5990  DATA 0.786026936,-6.07407E-03, 4.7138E-05
6000  DATA 0.726015713,-6.06173E-03,4.60157E-05
```

```
6010 REM UNIT (PER GUN) SOURCE STRENGTHS.
6020 DATA 18.7,1737.3,77.1,7076.2
6030 REM WP VOLUME SOURCE SIGMAS (U(2,2)).
6040 DATA 5.4,7.9,1.8,2.6
6050 REM STABILITY CONSTANTS FOR WP SMOKE.
6060 DATA 0.016, 0.016,0.016,0.016,0.016,0.016
6070 DATA "VISIBLE"
6080 DATA "NEAR IR"
6090 DATA "MID IR"
6100 DATA "FAR IR"
6110 END
```

APPENDIX L

APPLE II (BASIC) ALGORITHM

```
]LIST 10,4200

10  REM  KWIK SMOKE ALGORITHM FEB
     .,1982, PROGRAMMER SUE HANSE
     N
20  REM  KWIK METEOROLOGICAL INPU
     TS AND CALCULATIONS.
30 D$ = "": REM  CONTROL D
40  DIM C(4,2),T(4,4),V(2),W(6),Y
     (4,2),Z(4,2),S(6,3),A(6),Q(2
     ),H5(2,2),D5(6,3),U(2,2),R5(
     4,2),I(4,2),J(4,2),P5(4,2)
50  DIM E(4,2),F(4,2),G5(4,2),Q9(
     4,2),L(4,2),B(4),G(4),H(4),R
     (4),D(2),X(4),P(7,9)
60 PI = 3.1415927
63  DEF  FN A(A) =  EXP ( - S * A
      / 2)
64  DEF  FN B(B) =  EXP ( - (B *
     B))
65  DEF  FN C(C) =  EXP (C * S *
      LOG (.1 / H(I)))
66  DEF  FN D(D) =  EXP ( - D * S
      / 4.1)
70  PRINT D$;"PR# 4"
120  INPUT "MET SITE ID      ";I$
130  INPUT "LATITUDE OF MET SITE
     IN DEG   ";LO
140  INPUT "DIR. FROM EQUATOR (N=
     1&S=-1)  ";HS
150 LO = LO * HS
160  INPUT "LONGITUDE OF MET SITE
      IN DEG   ";L1
170  INPUT "DIRECTION FROM GREENW
     ICH (W=1&E=-1)   ";JS
180 L1 = L1 * JS
190  INPUT "ALTITUDE OF MET SITE
     - KILOMETERS   ";ZO
200  INPUT "JULIAN DATE OF MET OB
     SERVATION   ";JO
210  INPUT "ZULU TIME OF MET OBSE
     RVATION-HR   ";HO
220  INPUT "CEILING - FEET      ";
     CO
225 CO = CO * .3048
230  INPUT "CLOUD COVER-PERCENT
        ";C1
240  INPUT "VISIBILITY-MILES
     ";VO
245 VO = VO * 1.61
250  INPUT "PRECIPITATION(1=YES&0
     =NO)  ";P
260  INPUT "TEMPERATURE-DEG F
      ";TO
265 TO = 5 / 9 * (TO - 32)
270  INPUT "DEW POINT-DEG F      "
     ;T1
275 T1 = 5 / 9 * (T1 - 32)
280  INPUT "WIND DIRECTION-DEG
      ";DO
290  INPUT "WIND SPEED-KNOTS
     ";SO
```

```
300  INPUT "AVE ROUGHNESS ELEMENT
     -CM     ";Y
310  INPUT "SLANT RANGE TO TARGET
     -KM     ";H3
320  INPUT "ANGLE OF SIGHT TO TAR
     GET-DEG     ";S
330  INPUT "DIRECTION OF LINE OF
     SIGHT-DEG   ";A9
340  INPUT "SCREEN LENGTH-METERS
         ";XO
350  INPUT "DURATION-MINUTES
     ";T2
355  TEXT
356  PRINT : PRINT  TAB( 10)"MUNI
     TION EXPENDITURES"
357  PRINT  TAB( 11)"FOR HC AND W
     P SMOKE": PRINT
360  PRINT "ID" SPC( 27)"= "I$
370  PRINT "LATITUDE" SPC( 9)"-DE
     G" SPC( 8)"= "LO
380  PRINT "LONGITUDE" SPC( 8)"-D
     EG" SPC( 8)"= "L1
390  PRINT "ALTITUDE" SPC( 9)"- K
     M" SPC( 8)"= "ZO
400  PRINT "JULIAN DATE" SPC( 6)"
     -DAY" SPC( 8)"= "JO
410  PRINT "ZULU TIME" SPC( 8)"-H
     OURS" SPC( 6)"= "HO
420  PRINT "CEILING" SPC( 10)"-ME
     TERS      = "CO
430  PRINT "CLOUD COVER" SPC( 6)"
     -PERCENT     = "C1
438 XD =  INT (VO * 10 + .5) / 10

440  PRINT "VISIBILITY" SPC( 7)"-
     KILOMETERS = "XD
450  PRINT "PRECIPITATION" SPC( 1
     6)"= "P
458 XD =  INT (TO * 10 + .5) / 10

460  PRINT "TEMPERATURE" SPC( 6)"
     -DEG C" SPC( 6)"= "XD
468 XD =  INT (T1 * 10 + .5) / 10

470  PRINT "DEW POINT" SPC( 8)"-D
     EG C" SPC( 6)"= "XD
480  PRINT "WIND DIRECTION" SPC(
     3)"-DEG" SPC( 8)"= "DO
490  PRINT "WIND SPEED" SPC( 7)"-
     KNOTS" SPC( 6)"= "SO
500  PRINT "AVE ROUGHNESS ELEMENT
      -CM      = "Y
501  PRINT D$;"PR# 0"
502  INPUT "ARE ABOVE ENTRIES COR
     RECT (1=YES&0=NO) ";XD
503  IF XD = 0 THEN 70
504  PRINT D$;"PR# 4"
510  FOR J = 1 TO 9
520  FOR I = 1 TO 7
530  READ P(I,J)
540  NEXT I
550  NEXT J
560  REM  MET CALCULATIONS
```

```
570  IF C1 <  > 100 THEN 600
580  IF C0 > 2133.6042 THEN 600
590 I1 = 0:I2 = 0: GOTO 1050
600  REM  CALCULATE ANGULAR FRACI
     ON OF A YEAR FOR A GIVEN JUL
     IAN DATE (A0)
610 R9 = PI / 180:D9 = 180 / PI:L
     0 = L0 * R9
620 A0 = (J0 - 1) * 360 / 365.242

630  REM   CALCULATE SOLAR DECLIN
     ATION ANGLE (A4)
640 A1 = A0 * R9:A2 = 279.9348 +
     A0
650 A2 = A2 + 1.914827 *  SIN (A1
     ) - .079525 *  COS (A1) + .0
     19938 *  SIN (2 * A1) - .001
     62 *  COS (2 * A1)
660 A2 = A2 * R9:A3 = 23.4438 * R
     9:A4 =  SIN (A3) *  SIN (A2)

670 A4 =  ATN (A4 /  SQR (1 - A4 *
     A4))
680  REM  CALCULATE THE TIME OF M
     ERIDAN PASSAGE-TRUE SOLAR NO
     ON (A5)
690 A5 = 12 + .12357 *  SIN (A1) -
     .004289 *  COS (A1)
700 A5 = A5 + .153809 *  SIN (2 *
     A1) + .060783 *  COS (2 * A1
     )
710  REM  CALCULATE SOLAR ANGLE (
     A6)
720 A6 = (15 * (H0 - A5) - L1) *
     R9
730  REM  CALCULATE SOLAR ALTITUD
     E (A7)
740 A7 =  SIN (L0) *  SIN (A4) +
      COS (L0) *  COS (A6) *  COS
     (A4)
750 A7 = ( ATN (A7 /  SQR (1 - A7
      * A7))) * D9
760  REM  CALCULATE INSOLATION CL
     ASS NUMBER
770 I2 = 0
780  IF A7 <  = 60 THEN 800
790 I2 = 4: GOTO 860
800  IF A7 <  = 35 THEN 820
810 I2 = 3: GOTO 860
820  IF A7 <  = 15 THEN 840
830 I2 = 2: GOTO 860
840  IF A7 <  = 0 THEN 1010
850 I2 = 1
860  REM  CALCULATE NET RADIATION
      INDEX FOR DAYTIME.
870 I3 = 0
880  IF C1 > 50 THEN 900
890 I3 = I2: GOTO 960
900  IF C0 >  = 2133.6042 THEN 92
     0
910 I3 = I2 - 2: GOTO 960
920  IF C0 >  = 4876.8096 THEN 94
     0
```

```
930 I3 = I2 - 1: GOTO 960
940  IF C1 <  > 100 THEN 960
950 I3 = I2 - 1
960  IF I3 <  > 0 THEN 980
970 I3 = I2
980  IF I3 > 1 THEN 1000
990 I3 = 1
1000 I1 = I3: GOTO 1050
1010  REM  CALCULATE NET RADIATIO
     N INDEX FOR NIGHTTIME
1020  IF C1 > 40 THEN 1040
1030 I1 =  - 2: GOTO 1050
1040 I1 =  - 1
1050  REM  CALCULATE PASQUILL STA
     BILITY CATEGORY
1060 I4 = 0:I5 = 0: IF I1 <  > 4 THEN
     1080
1070 I4 = 1
1080  IF I1 <  > 3 THEN 1100
1090 I4 = 2
1100  IF I1 <  > 2 THEN 1120
1110 I4 = 3
1120  IF I1 <  > 1 THEN 1140
1130 I4 = 4
1140  IF I1 <  > 0 THEN 1160
1150 I4 = 5
1160  IF I1 <  >  - 1 THEN 1180
1170 I4 = 6
1180  IF I1 <  >  - 2 THEN 1200
1190 I4 = 7
1200  IF S0 > 2 THEN 1220
1210 I5 = 1: GOTO 1450
1220  IF S0 >  = 4 THEN 1240
1230 I5 = 2: GOTO 1450
1240  IF S0 >  = 6 THEN 1260
1250 I5 = 3: GOTO 1450
1260  IF S0 >  = 7 THEN 1280
1270 I5 = 4: GOTO 1450
1280  IF S0 >  = 8 THEN 1300
1290 I5 = 5: GOTO 1450
1300  IF S0 >  = 10 THEN 1400
1310 I5 = 6: GOTO 1450
1400  IF S0 >  = 11 THEN 1420
1410 I5 = 7: GOTO 1450
1420  IF S0 >  = 12 THEN 1440
1430 I5 = 8: GOTO 1450
1440 I5 = 9
1450 P0 = P(I4,I5)
1460  REM  CALCULATE RELATIVE HUM
     IDITY
1470  IF T0 > 0 THEN 1490
1480 A0 = 9.5:B0 = 265.5: GOTO 15
     00
1490 A0 = 7.5:B0 = 237.3
1500  IF T1 > 0 THEN 1610
1600 A1 = 9.5:B1 = 265.5: GOTO 16
     15
1610 A1 = 7.5:B1 = 237.3
1615 E0 = 6.11 * 10 ^ (A0 * T0 /
     (B0 + T0)):E1 = 6.11 * 10 ^
     (A1 * T1 / (B1 + T1)):R0 = E
     1 / E0 * 100
1620  PRINT "PASQUILL STABILITY C
```

```
     ATEGORY  = " MID$ ("ABCDEF",
     P0,1)
1628 XD =  INT (R0 * 10 + .5) / 1
     0
1630  PRINT "RELATIVE HUMIDITY" SPC(
     12)"= "XD
1640  PRINT : PRINT
1643  REM  KWIK ATMOSPHEREC OPTIC
     S AND SMOKE CONCENTRATION CA
     LCULATIONS
1647  FOR I = 1 TO 4: READ B(I),G
     (I),X(I): NEXT
1650 V1 =  LOG (V0):V2 = V1 * V1:
     V3 = V2 * V1
1660 H(1) =  EXP (1.5551 - .9811 *
     V1 - .0197 * V2 + .0041 * V3
     ):H(2) =  EXP (1.50381511 -
     .992319519 * V1 - .015972801
      * V2 + .00368583 * V3)
1670 H(3) =  EXP (1.2394 - 1.0436
      * V1 + .0099 * V2 - .0016 *
     V3):H(4) =  EXP (1.5176 - 1.
     7147 * V1 + .0001 * V2 + .04
     28 * V3)
1680 R(1) =  EXP (1.3306 - .8825 *
     V1 - .0753 * V2 + .0129 * V3
     ):R(2) =  EXP (1.48195171 -
     .92259583 * V1 - .06550942 *
     V2 + .01368042 * V3)
1690 R(3) =  EXP (1.5556 - .9013 *
     V1 - .0773 * V2 + .0173 * V3
     ):R(4) =  EXP (1.5928 - .939
     6 * V1 - .0627 * V2 + .0168 *
     V3)
1700 H0 = 0: IF S >  = 0 THEN 172
     0
1710 S =  - S
1720 S = S * (PI / 180):S =  SIN
     (S):H4 = 0
1730  IF S = 0 THEN 1750
1740 H4 = 1 / S
1750  REM  CALCULATE PRECIPITABLE
      WATER
1760 W = .4477 + .0328 * T1 + .00
     02 * T1 * T1 + .0000184 * T1
      * T1 * T1
1770  REM  CALCULATE AMOUNT OF WA
     TER IN PATH
1790 L0 = H3:L1 = H0:L2 = L0:L3 =
     .5 * (L1 + L2):L4 = L2 - L1:
     L5 = .2886751 * L4
1800 W0 = .5 * L4 * ( FN A(L3 + L
     5) +  FN A(L3 - L5))
1805 W1 = W * W0
1810  REM  CALCULATE TRANSMITTANC
     ES FOR VISUAL,NEAR,MID AND F
     AR IR WAVELENGTHS
1820  FOR I = 1 TO 4
1830  REM  CALCULATE TRANSMITTANC
     ES OWING TO ABSORPTION BY WA
     TER VAPOR
1840  IF I <  > 4 THEN 1870
1850 T(I,1) =  EXP ( - .0681 * W1
```

```
     ): GOTO 1890
1870 LO = B(I) *  SQR (W1 * PI) /
     2:L1 = HO:L2 = LO:L3 = .5 *
     (L1 + L2):L4 = L2 - L1:L5 =
     .2886751 * L4
1880 M2 = .5 * L4 * ( FN B(L3 + L
     5) +  FN B(L3 - L5)):T(I,1) =
     2 /  SQR (PI) * M2:T(I,1) =
     1 - T(I,1)
1890  REM  CALCULATE TRANSMITTANC
     E OWING TO ATTENUATION BY HA
     ZE AND FOG
1900  IF P = 0 THEN 1920
1910 T(I,2) = 1: GOTO 2010
1920  IF VO >  = G(I) THEN 1990
1940 LO = H4:L1 = HO:L2 = LO:L3 =
     .5 * (L1 + L2):L4 = L2 - L1:
     L5 = .288675 * L4
1950 T3 =      .5 * L4 * ( FN C(L3
      + L5) +  FN C(L3 - L5))
1955 T4 =  EXP ( - H(I) * T3)
1970 L1 = H4:L2 = H3:L3 = .5 * (L
     1 + L2):L4 = L2 - L1:L5 = .2
     886751 * L4
1980 T5 = .5 * L4 * ( FN D(L3 + L
     5) +  FN D(L3 - L5)):T6 =  EXP
     ( - .128 * T5):T(I,2) = T4 *
     T6: GOTO 2010
1990 LO = H3:L1 = HO:L2 = LO:L3 =
     .5 * (L1 + L2):L4 = L2 - L1:
     L5 = .2886741 * L4
2000 T7 = .5 * L4 * ( FN D(L3 + L
     5) +  FN D(L3 - L5)):T(I,2) =
      EXP ( - H(I) * T7)
2010  REM  CALCULATE TRANSMITTANC
     E OWING TO ATTENUATION BY PR
     ECIPATION
2020  IF P = 1 THEN 2040
2030 T(I,3) = 1: GOTO 2060
2040  IF VO > 20 THEN 2030
2050 T(I,3) =  EXP ( - H3 * R(I))

2060  REM  CALCULATE TRANSMITTANC
     E OWING TO ATTENUATION BY SM
     OKE
2070 T(I,4) = X(I) / (T(I,1) * T(
     I,2) * T(I,3))
2080  IF T(I,4) <  = 1 THEN 2100
2090 T(I,4) = 1
2100  REM  CALCULATE LINE OF SIGH
     T INTEGRATED CONCENTRATION
2110  FOR K = 1 TO 2: READ D(K): NEXT

2120  IF T(I,4) <  > 1 THEN 2140
2130  FOR J = 1 TO 2:C(I,J) = 0: NEXT

2135  GOTO 2190
2140  FOR K = 1 TO 2
2150  IF D(K) <  > 0 THEN 2170
2160 C(I,K) = 0: GOTO 2180
2170 C(I,K) =  LOG (T(I,4)) /  -
     D(K)
2180  NEXT K
```

```
2190  NEXT I
2200  REM  ATMOSPHERIC DIFFUSION
     CALCULATIONS.
2210  FOR L = 1 TO 6: READ A(L): NEXT

2220  FOR I = 1 TO 6
2230  FOR J = 1 TO 3: READ S(I,J)
     : NEXT
2240  NEXT I
2250  FOR I = 1 TO 6
2260  FOR J = 1 TO 3: READ D5(I,J
     ): NEXT
2270  NEXT I
2280  READ H5(1,1),H5(1,2),H5(2,1
     ),H5(2,2)
2290  READ U(1,1),U(2,1),U(1,2),U
     (2,2)
2300 A1 =  - 1.24 + 1.19 * ( LOG
     (Y) /  LOG (10)):Z = 10 ^ A1
     :A2 =  ABS (A9 - D0) * (PI /
     180):R2 =  SQR (13.69 / (13.
     68 *  SIN (A2) *  SIN (A2) +
      COS (A2) *  COS (A2)))
2310 Y1 = 1.0952155 + .0290689 *
     R0 - .00049575 * R0 * R0 + .
     00000482 * R0 * R0 * R0:Y2 =
     3.364059144 + .060502571 * R
     0 - .00115301 * R0 * R0 + .0
     000133942 * R0 * R0 * R0
2320 C2 = S(P0,1) + S(P0,2) * Z +
     S(P0,3) * Z * Z:D1 = D5(P0,1
     ) + D5(P0,2) * Z + D5(P0,3) *
     Z * Z:D2 = 1 / D1
2330  IF S0 <  > 0 THEN 2350
2340 S0 = 1
2350 S3 = .515 * S0
2360  FOR N = 1 TO 6: READ W(N): NEXT

2370  FOR I = 1 TO 4
2380  FOR K = 1 TO 2: REM  CALCUL
     ATE CROSSWWIND INTEGRATED CO
     NCENTRATION FOR WP SMOKE
2390  IF (I < 3) AND (P0 > 4) THEN
     2410
2400 S1 = U(K,1) + .74 * A(P0) *
     100 ^ .9:S2 = U(K,2) + .667 *
     C2 * 100 ^ D1:V(K) = W(P0) *
     Y2 * H5(K,2) / (PI * S1 * S2
     )
2410  REM  MUNITION EXPENDITURES
     (HC SMOKE)
2420 Q(1) = .4:Q(2) = .4: REM  MU
     NITION EFFICIENCIES
2430  REM  SUSTAINING SHELL SPACI
     NG FOR HC SMOKE
2440  IF I > 2 THEN 2500
2450  IF C(I,1) <  > 0 THEN 2470
2460 Y(I,K) = 0: GOTO 2500
2470 Y(I,K) = 1 / R2 * (.731 * Q(
     K) * Y1 * H5(K,1) / (C2 * S3
      * C(I,1))) ^ D2
2480  IF Y(I,K) < X0 THEN 2500
2490 Y(I,K) = X0
```

```
2500  NEXT K
2510  NEXT I
2520  FOR I = 1 TO 4
2530  FOR K = 1 TO 2
2540  IF I > 2 THEN 2740
2550 I(I,K) = S3 * 45: REM  CALCU
     LATE INITIAL SHELL SPACING F
     OR HC SMOKE
2560  IF Y(I,K) <  > 0 THEN 2580
2570 E(I,K) = 1:F(I,K) = 1: GOTO
     2670
2580  REM  CALCULATE INITIAL VOLL
     EY FOR HC SMOKE
2590  IF I(I,K) > Y(I,K) THEN 261
     0
2600  GOTO 2615
2610 I(I,K) = Y(I,K)
2615 E(I,K) = X0 / I(I,K):Q5 =  INT
     (E(I,K)):Q6 = E(I,K) - Q5
2620  IF Q6 < .5 THEN 2640
2630 E(I,K) = Q5 + 1
2640 F(I,K) = X0 / Y(I,K):Q5 =  INT
     (F(I,K)):Q6 = F(I,K) - Q5: REM
      NUMBER OF GUNS FOR SUSTAINI
     NG VOLLEYS
2650  IF Q6 < .5 THEN 2670
2660 F(I,K) = Q5 + 1
2670 R1 = .5: REM  RATE OF FIRE F
     OR HC SMOKE
2680  IF C(I,1) <  > 0 THEN 2700
2690 R1 = 0
2700  REM  CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (HC SMOK
     E)
2710 J(I,K) = E(I,K) + (R1 * T2 -
     1) * F(I,K):Q5 =  INT (J(I,K
     )):Q6 = J(I,K) - Q5
2720  IF Q6 < .5 THEN 2740
2730 J(I,K) = Q5 + 1
2740  IF (I < 3) AND (P0 > 4) THEN
     3070
2750  REM  SHELL SPACING <L() &Z(
     ) & VOLLEYS <G() &Q()>-WP SM
     OKE
2760  IF C(I,2) <  > 0 THEN 2780
2770 Z(I,K) = 0:G5(I,K) = 0:Q9(I,
     K) = 0: GOTO 2860
2780  IF I > 2 THEN 2820
2790 L(I,K) = V(K) / C(I,2) * 100
     : IF L(I,K) < X0 THEN 2810
2800 L(I,K) = X0:
2810 Z(I,K) = L(I,K):G5(I,K) = X0
      / Z(I,K): GOTO 2825
2820 G5(I,K) = .6 * C(I,2) / V(K)

2825 Q5 =  INT (G5(I,K)):Q6 = G5(
     I,K) - Q5
2826  IF Q6 < .5 THEN 2840
2830 G5(I,K) = Q5 + 1: GOTO 2850
2840 G5(I,K) = Q5
2850 Q9(I,K) = G5(I,K)
2860  REM  RATE OF FIRE FOR WP SM
     OKE
```

```
2870  IF C(I,2) <  > 0 THEN 2890
2880 R5(I,K) = 0: GOTO 2980
2890  IF I > 2 THEN 2910
2900 R5(I,K) = (Z(I,K) + 60) / S3
     : GOTO 2915
2910 R5(I,K) = 120 / S3
2915 R5(I,K) = R5(I,K) / 20:R5 =
      INT (R5(I,K)):R6 = R5(I,K) -
     R5
2920  IF R6 < .5 THEN 2940
2930 R5 = R5 + 1
2940  IF R5 <  > 0 THEN 2960
2950 R5 = 1
2960 R5(I,K) = R5 * 20 / 60:R5(I,
     K) = 1 / R5(I,K)
2970  IF R5(I,K) < 1 THEN R5(I,K)
      = 1
2980  REM  CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (WP SMOK
     E)
2990  IF C(I,2) <  > 0 THEN 3010
3000 P5(I,K) = 0: GOTO 3310
3010  IF I > 2 THEN 3030
3020 P5(I,K) = (T2 * R5(I,K) - 1)
      * Q9(I,K) + G5(I,K): GOTO 3
     040
3030 P5(I,K) = Q9(I,K) * (X0 / 60
      + 1) * (T2 * R5(I,K) - 1)
3040 Q5 =  INT (P5(I,K)):Q6 = P5(
     I,K) - Q5
3050  IF Q6 < .5 THEN 3300
3060 P5(I,K) = Q5 + 1: GOTO 3300
3070  REM  CALCULATIONS FOR WP SM
     OKE E&F STABILITY CATEGORIES
     (STABLE FLOW)
3080  REM  INITIAL SHELL SPACING
3090  IF (I = 1) AND (K = 1) THEN
     3120
3100  IF (I < 3) AND (K = 2) THEN
     3120
3110  IF (I = 2) AND (K = 1) THEN
     3130
3120 L(I,K) = 100: GOTO 3140
3130 L(I,K) = 50
3140  REM  SUSTAINING SHELL SPACI
     NG
3150  IF (I = 1) AND (K = 1) THEN
     3190
3160  IF (I = 2) AND (K = 2) THEN
     3190
3170  IF (I = 1) AND (K = 2) THEN
     3200
3180  IF (I = 2) AND (K = 1) THEN
     3210
3190 Z(I,K) = 100: GOTO 3220
3200 Z(I,K) = 200: GOTO 3220
3210 Z(I,K) = 50
3220 G5(I,K) = X0 / L(I,K) + 1: REM
      INITIAL VOLLEY
3230 Q9(I,K) = X0 / Z(I,K) + 1: REM
      SUSTAINING VOLLEY
3240  REM  RATE OF FIRE
3250  IF K = 1 THEN 3270
```

```
3260  IF K = 2 THEN 3280
3270 R5(I,K) = 2: GOTO 3290
3280 R5(I,K) = 1
3290 P5(I,K) = (T2 * R5(I,K) - 1)
      * Q9(I,K) + G5(I,K): REM  T
     OTAL NO. OF ROUNDS REQUIRED
3300  NEXT K
3310  NEXT I
3320  FOR I = 1 TO 4
3324  PRINT D$;"PR# 0"
3325  INPUT "PRESS 1 AND RETURN W
     HEN READY FOR OUTPUT  ";XD
3326  IF XD <  > 1 THEN 3325
3327  PRINT D$;"PR# 4"
3330  PRINT : PRINT : PRINT : PRINT
     : PRINT : PRINT : PRINT
3340  READ A$
3345  PRINT  TAB( 14)A$
3350  PRINT  TAB( 25)"METERS MINU
     TES"
3355 XO =  INT (XO + .5):T2 =  INT
     (T2 + .5)
3360  PRINT "SCREEN LENGTH/DURATI
     ON:  "XO"    "T2
3370  IF I > 2 THEN 3600
3380  PRINT  TAB( 11)"HC SMOKE SC
     REEN": PRINT  TAB( 11)"105MM
      HOWITZER"
3390  PRINT "VOLLEY     GUNS RATE
     / SPACING ROUNDS"
3400 E(I,1) =  INT (E(I,1) + .5):
     I(I,1) =  INT (I(I,1) + .5)
3410  PRINT "INITIAL" TAB( 13)E(I
     ,1) TAB( 25)I(I,1)
3420 F(I,1) =  INT (F(I,1) + .5):
     R1 =  INT (R1 * 10 + .5) / 1
     0:Y(I,1) =  INT (Y(I,1) + .5
     ):J(I,1) =  INT (J(I,1) + .5
     )
3430  PRINT "SUSTAINING" TAB( 13)
     F(I,1) TAB( 18)R1 TAB( 25)Y(
     I,1) TAB( 32)J(I,1)
3440  PRINT "VOLLEY     GUNS RATE
     / SPACING ROUNDS": PRINT  TAB(
     17)"MIN   METERS"
3450 E(I,2) =  INT (E(I,2) + .5):
     I(I,2) =  INT (I(I,2) + .5)
3460  PRINT "INITIAL" TAB( 13)E(I
     ,2) TAB( 25)I(I,2)
3470 F(I,2) =  INT (F(I,2) + .5):
     Y(I,2) =  INT (Y(I,2) + .5):
     J(I,2) =  INT (J(I,2) + .5)
3480  PRINT "SUSTAINING" TAB( 13)
     F(I,2) TAB( 18)R1 TAB( 25)Y(
     I,2) TAB( 32)J(I,2)
3490  PRINT  TAB( 11)"WP SMOKE SC
     REEN": PRINT  TAB( 11)"105MM
      HOWITZER": PRINT "VOLLEY
       GUNS RATE/ SPACING ROUNDS"
     : PRINT  TAB( 17)"MIN   METE
     RS"
3500 G5(I,1) =  INT (G5(I,1) + .5
     ):L(I,1) =  INT (L(I,1) + .5
```

```
)
3510  PRINT "INITIAL" TAB( 13)G5(
     I,1) TAB( 25)L(I,1)
3520 Q9(I,1) =  INT (Q9(I,1) + .5
     ):R5(I,1) =  INT (R5(I,1) *
     10 + .5) / 10:Z(I,1) =  INT
     (Z(I,1) + .5):PR(I,1) =  INT
     (P5(I,1) + .5)
3530  PRINT "SUSTAINING" TAB( 13)
     Q9(I,1) TAB( 18)R5(I,1) TAB(
     25)Z(I,1) TAB( 32)P5(I,1)
3540  PRINT "VOLLEY      GUNS RATE
     / SPACING ROUNDS": PRINT  TAB(
     17)"MIN METERS"
3550 G5(I,2) =  INT (G5(I,2) + .5
     ):L(I,2) =  INT (L(I,2) + .5
     )
3560  PRINT "INITIAL" TAB( 13)G5(
     I,2) TAB( 25)L(I,2)
3570 Q9(I,2) =  INT (Q9(I,2) + .5
     ):R5(I,2) =  INT (R5(I,2) *
     10 + .5) / 10:Z(I,2) =  INT
     (Z(I,2) + .5):P5(I,2) =  INT
     (P5(I,2) + .5)
3580  PRINT "SUSTAINING" TAB( 13)
     Q9(I,2) TAB( 18)R5(I,2) TAB(
     25)Z(I,2) TAB( 32)P5(I,2)
3590  IF I < 3 THEN 3650
3600  PRINT  TAB( 11)"WP SMOKE SC
     REEN": PRINT  TAB( 6)"ROUNDS
     /     RATE/     TOTAL": PRINT
      TAB( 5)"60 METERS   MINUTE
       ROUNDS"
3610 Q9(I,1) =  INT (Q9(I,1) + .5
     ):R5(I,1) =  INT (R5(I,1) *
     10 + .5) / 10:P5(I,1) =  INT
     (P5(I,1) + .5)
3620  PRINT "105MM:" TAB( 10)Q9(I
     ,1) TAB( 18)R5(I,1) TAB( 27)
     P5(I,1)
3630 Q9(I,2) =  INT (Q9(I,2) + .5
     ):R5(I-2) =  INT (R5(I,2) *
     10 + .5) / 10:P5(I,2) =  INT
     (P5(I,2) + .5)
3640  PRINT "155MM:" TAB( 10)Q9(I
     ,2) TAB( 18)R5(I,2) TAB( 27)
     P5(I,2)
3650  NEXT I
3660  PRINT : PRINT : PRINT : PRINT
     : PRINT : PRINT
3670  PRINT D$"PR# 0"
3680  PRINT "FINISHED"
3690  REM  PASQUILL STABILITY CAT
     EGORY DATA
3700  DATA  1,1,2,3,4,6,6
3710  DATA  1,2,2,3,4,6,6
3720  DATA  1,2,3,4,4,5,6
3730  DATA  2,2,3,4,4,5,6
3740  DATA  2,2,3,4,4,4,5
3750  DATA  2,3,3,4,4,4,5
3760  DATA  3,3,4,4,4,4,5
3770  DATA  3,3,4,4,4,4,4
3780  DATA  3,4,4,4,4,4,4
```

```
3890  REM  ABSORPTION COEFFICIENT
     ,SCALE HEIGHT,& WAVELENGTH T
     HRESHOLD
3900  DATA  0.118,26.7,0.05
3910  DATA  0.18,7.5,0.05
3920  DATA  0.55,5.1,0.05
3930  DATA  0,5,0.05
3940  REM  EXTINCTION COEFICIENTS
      FOR HC AND WP
3950  DATA  3.3,2.46
3960  DATA  1.5,2
3970  DATA  0,0.25
3980  DATA  0,0.32
3990  REM  DATA USED TO CALCULATE
      SIGMA Y FOR CONTINUOUS SOUR
     CE
4000  DATA  0.4,0.32,0.22,0.144,0
     .102,0.076
4010  REM  DATA USED TO CALCULATE
      SIGMA Z FOR CONTINUOUS SOUR
     CE
4020  DATA  .1390853,.01501728,-.
     00010258
4030  DATA  .12209764,.0109704,-.
     000068014
4040  DATA  .11010438,.01096296,-
     .00006734
4050  DATA  .09764983,.01041852,-
     .00006835
4060  DATA  .07077217,.00727284,-
     .000045006
4070  DATA  .05548709,.0065531,-.
     00004018
4080  DATA  .94481482,-.0048519,.
     000037037
4090  DATA  .89480359,-.0048395,.
     000035915
4100  DATA  .85479237,-.0048272,.
     0000347924
4110  DATA  .81602694,-.0060741,.
     000047138
4120  DATA  .78602694,-.00607407,
     .000047138
4130  DATA  .72601571,-.0060617,.
     0000460157
4140  REM  UNIT (PER GUN) SOURCE
     STRENGTHS
4150  DATA  18.7,1737.3,77.1,7076
     .2
4153  REM  WP VOL. OURCE SIGMAS (
     U(2,2))
4157  DATA  5.4,7.9,1.8,2.6
4160  REM  STABILITY CONSTANTS FO
     R WP SMOKE
4170  DATA  0.016,0.016,0.016,0.0
     16,0.016,0.016
4180  DATA  "VISIBLE","NEAR IR","
     MID IR","FAR IR"
4190  END
```

APPENDIX M

KWIK ALGORITHM FOR VOLUME OF FIRE TABLES
GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1.	A	Index for relative humidity indicator
2.	B	Index for 105- and 155-mm howitzer indicator
3.	C	Visibility - miles
4.	D	Index for stability/windspeed indicator
5.	E	Dewpoint - degrees Fahrenheit
6.	F	Wind direction - degrees
7.	G;V(6)	Windspeed - meters per second
8.	H	Index for stability/windspeed algorithms
9.	I	Index for wavelength algorithms
10.	J	Index for smoke algorithms
11.	K	Index for gun (105- or 155-mm howitzer) algorithms
12.	L	Index for smoke screen length algorithms
13.	M	Index for smoke screen duration algorithms
14.	N	Temperature - degrees Fahrenheit
15.	P	Initial volley for HC smoke
16.	Q	Relative humidity - percent
17.	V	Direction of line of sight - degrees
18.	Z	Roughness length - centimeters
19.	r6	Angle of sight to target - degrees
20.	r20	Slant range to target - kilometers
21.	r21	Wavelength threshold level
22.	A(7)	HC smoke screen length - meters,
23.	B(2,4)	Table of transmittances resulting from water vapor, haze/fog, precipitation and smoke for visible, near, mid, and far infrared wavelengths
24.	C(4,2)	Table of smoke concentration values for HC and WP smoke for visible, near, mid, and far infrared wavelengths
25.	D(4)	Absorption coefficient error function
26.	E(4)	Scale height for Mie scattering
27.	F(4)	Haze and fog attenuation coefficients
28.	G(4)	Precipitation attenuation coefficients
29.	H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations visible, near, mid, and far infrared wavelengths
30.	I(6)	Constant related to stability category for WP smoke
31.	J(6)	Coefficients to compute sigma y
32.	K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
33.	M(2)	Yield factors for HC and WP

34.	N(2)	Crosswind integrated concentration for WP smoke
35.	O(5)	WP smoke screen length - meters
36.	P(2,2,6,7,4)	Total number of rounds required to maintain HC and WP smoke screen
37.	Q(6,4,2)	Number of guns (105- and 155-mm howitzer) for HC smoke for visible and infrared wavelengths and all stability categories
38.	S(2,2)	Unit (per gun) source strength
39.	T(2)	Munition efficiency for 105- and 155-mm howitzer, for HC smoke
40.	U(2,2)	WP volume source sigmas for 105- and 155-mm howitzer
41.	V(6);G	Windspeed - meters per second
42.	W(7,4)	HC smoke screen duration - minutes
43.	X(5,4)	WP smoke screen duration - minutes
44.	Y(6,4,2)	Shell spacing for 105- and 155-mm howitzer for HC smoke
45.	Z(6,4,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
46.	A$(112)	Screen length identifier
47.	B$(6)	105- and 155-mm howitzer indicator
48.	C$(32)	Wavelength indicator 9. D$(3)
Precipitation indicator		
50.	E$(4)	HC or WP smoke indicator
51.	G$(54)	Stability/windspeed indicator
52.	H$(81)	Relative humidity indicator
53.	O$80	Smoke screen length indicator
54.	W$(112)	HC smoke screen duration indicator
55.	X$(80)	WP smoke screen duration indicator

APPENDIX N

VOLUME OF FIRE TABLES
(HPL/HP9825A) ALGORITHM

```
0: "VOLUME OF FIRE TABLES (08/03/81)":
1: dim A[7],B[4],E[4],H[2,4],J[6],K[6,3],L[6,3],S[2,2],V[6],C$[32]
2: dim D[2,4],J[4,2],F[4],G[4],I[6],M[2],T[2]
3: dim N[2],O[7],P[2,2,6,7,4],Q[6,4,2],O$[80]
4: dim U[2,2],W[7,4],Y[6,4,2],Z[6,4,2],X[5,4]
5: dim A$[112],B$[6],D$[3],E$[4],H$[81],W$[112],G$[54],X$[80]
6: "INITIALIZATION":
7: cli 7;cli 7
8: for 1,B[*],E[*],H[*],J[*],K[*],L[*],S[*],V[*],C$
9: 200→A[1];400→A[2];600→A[3];800→A[4];1000→A[5];1500→A[6];2000→A[7]
10: 100→O[1];200→O[2];300→O[3];400→O[4];600→O[5]
11: .4→T[1]→T[2]
12: "        200                 400                 600"→A$[1,48]
13: "        600                1000                1500                 2000"→A$[49,112]
14: "        100                 200                 300        "→O$[1,48]
15: "       400                 600"→O$[49,80]
16: "    A/ 5      B/ 8      C/10      D/15      E/ 8      F/ 6   "→G$[1,54]
17: "10%< RELATIVE HUMIDITY <20%"→H$[1,27]
18: "21%< RELATIVE HUMIDITY <59%"→H$[28,54]
19: "RELATIVE HUMIDITY >60%      "→H$[55,81]
20: "    5  10  15  20  10  15  20  25"→W$[1,32]
21: "   10  15  20  25  15  20  25  30"→W$[33,64]
22: "   15  20  25  30  20  25  30  35  20  25  30  35"→W$[65,112]
23: "    5  10  15  20   5  10  15  20"→X$[1,32]
24: "    5  10  15  20  10  15  20  25  10  15  20  25"→X$[33,80]
25: "105"→B$[1,3];"155"→B$[4,6]
26: "HC"→E$[1,2];"WF"→E$[3,4]
27: 5→W[1,1];10→W[1,2]→W[2,1]→W[3,1]
28: 15→W[1,3]→W[2,2]→W[3,2]→W[4,1]→W[5,1]
29: 20→W[1,4]→W[2,3]→W[3,3]→W[4,2]→W[5,2]→W[6,1]→W[7,1]
30: 25→W[2,4]→W[3,4]→W[4,3]→W[5,3]→W[6,2]→W[7,2]
31: 30→W[4,4]→W[5,4]→W[6,3]→W[7,3]
32: 35→W[6,4]→W[7,4]
33: 5→X[1,1]→X[2,1]→X[3,1]
34: 10→X[1,2]→X[2,2]→X[3,2]→X[4,1]→X[5,1]
35: 15→X[1,3]→X[2,3]→X[3,3]→X[4,2]→X[5,2]
36: 20→X[1,4]→X[2,4]→X[3,4]→X[4,3]→X[5,3]
37: 25→X[4,4]→X[5,4]
38: 5.4→U[1,1];7.9→U[2,1];1.8→U[1,2];2.6→U[2,2]
39: .016→I[1]→I[2]→I[3]→I[4]→I[5]→I[6]
40: "INPUTS":
41: ent " TEMPERATURE - DEG F",N
42: 5/9*(N-32)→N
43: 15→Q
44: ent "RELATIVE HUMIDITY (15,40 or 80) - PERCENT",Q
45: "VISIBILITY":
46: 25*1.61→C
47: "PRECIPITATION INDICATOR":"NO"→D$
48: "WIND DIRECTION - DEGREES":
49: 270→F
50: "ROUGHNESS LENGTH - CENTIMETERS":
*198
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51: 9.65→Z
52: "SLANT RANGE TO TARGET - KM":
53: Z→r20
54: "ANGLE OF SIGHT TO TARGET - DEG":
55: 0→r6
56: "DIRECTION OF LINE OF SIGHT - DEGREES":
57: 225→V
58: "ATMOSPHERIC OPTICS CALCULATIONS":
59: ln(C)→r0
60: r0*r0→r1
61: r1*r0→r2
62: 1.5551-.9811*r0-.0197*r1+.0041*r2→F[1]
63: exp(F[1])→F[1]
64: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2→F[2]
65: exp(F[2])→F[2]
66: 1.2394-1.0436*r0+.0099*r1-.0016*r2→F[3]
67: exp(F[3])→F[3]
68: 1.5176-1.7147*r0+.0001*r1+.0428*r2→F[4]
69: exp(F[4])→F[4]
70: 1.3306-.8825*r0-.0753*r1+.0129*r2→G[1]
71: exp(G[1])→G[1]
72: 1.461951707-.9225589*r0-.065509417*r1+.013680422*r2→G[2]
73: exp(G[2])→G[2]
74: 1.5556-.9013*r0-.0773*r1+.0173*r2→G[3]
75: exp(G[3])→G[3]
76: 1.5926-.9396*r0-.0627*r1+.0168*r2→G[4]
77: exp(G[4])→G[4]
78: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
79: sin(r6)→r6
80: 0→r8
81: if r6#0;1/r6→r8
82: "CALCULATE DEW POINT":
83: if N>0;gto "K1600"
84: 9.5→r0;265.5→r1
85: gto "K1700"
86: "K1600":
87: 7.5→r0;237.3→r1
88: "K1700":
89: 6.11*10^(r0*N/(r1+N))→r4
90: Q*r4/100→r5
91: r1*(log(r5)-log(6.11))/(r0-log(r5)+log(6.11))→E
92: "CALCULATE PRECIPITABLE WATER":
93: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3→r11
94: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
95: r20→r0;0→r1;r0→r2;.5*(r1+r2)→r3
96: r2-r1→r4;.2886751*r4→r5
97: .5*r4*('FNA'(r3+r5)+'FNA'(r3-r5))→r9
98: r11*r9→r10
99: "TRANS. OWING TO ATTEN. BY WATER VAPOR.":
100: for I=1 to 2
101: if I=4;exp(-.0681*r10)→B[1,1];gto "K2600"
*14445
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102: B[I]*√(r10*π)/2→r0;0→r1;r0→r2
103: .5*(r1+r2)→r3
104: r2-r1→r4
105: .2886751*r4→r5
106: .5*r4*('FNB'(r3+r5)+'FNB'(r3-r5))→r12
107: 2/√π*r12→B[I,1]
108: 1-B[I,1]→B[I,1]
109: "TRANS. OWING TO ATTEN. BY HAZE AND FOG.":
110: "K2600":
111: if D$="YES";1→B[I,2];gto "K2900"
112: if C>=E[I];gto "K2800"
113: r8→r0;0→r1;r0→r2
114: .5*(r1+r2)→r3
115: r2-r1→r4
116: .2886751*r4→r5
117: .5*r4*('FNC'(r3+r5)+'FNC'(r3-r5))→r13
118: exp(-F[I]*r13)→r14
119: r20-r8→r0;r8→r1;r8+r0→r2
120: .5*(r1+r2)→r3
121: r2-r1→r4
122: .2886751*r4→r5
123: .5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r15
124: exp(-.128*r15)→r16
125: r14*r16→B[I,2];gto "K2900"
126: "K2800":
127: r20→r0;0→r1;r0→r2;.5*(r1+r2)→r3
128: r2-r1→r4;.2886751*r4→r5
129: .5*r4*('FND'(r3+r5)+'FND'(r3-r5))→r17
130: exp(-F[I]*r17)→B[I,2]
131: "TRANS. OWING TO ATTEN. BY PRECIP.":
132: "K2900":
133: if D$="NO";1→B[I,3];gto "K3100"
134: if C>20;1→B[I,3];gto "K3100"
135: exp(-r20*G[I])→B[I,3]
136: "TRANS. OWING TO ATTEN. BY SMOKE.":
137: "K3100":
138: "WE THRES":
139: .05→r21
140: r21/(B[I,1]*B[I,2]*B[I,3])→B[I,4]
141: if B[I,4]>1;1→B[I,4]
142: "LINE OF SIGHT INTEGR. CONCEN.":
143: if B[I,4]=0;for J=1 to 2;0→C[I,J];next J;gto "K3500"
144: for J=1 to 2
145: if H[J,I]=0;0→C[I,J];gto "K3300"
146: ln(B[I,4])/-H[J,I]→C[I,J]
147: "K3300":next J
148: next I
149: "ATMOS. DIFF. CAL.":
150: "K3500":
151: abs(V-F)→r8
152: √(13.69/(13.69*sin(r8)*sin(r8)+cos(r8)*cos(r8)))→r18
*5948
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153: 1.09521547+.02906894*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q→M[1]
154: 3.364059144+.060502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q→M[2]
155: for I=1 to 2
156: for H=1 to 6
157: K[H,1]+K[H,2]*Z+K[H,3]*Z^2→r9
158: L[H,1]+L[H,2]*Z+L[H,3]*Z^2→r17
159: 1/r17→r11
160: V[H]→G
161: "CROSSWIND INTGR. CONC. FOR WP SMK.":
162: for K=1 to 2
163: if I<3;if H>4;gto "K3600"
164: U[K,1]+.74*U[H]*100^.9→r4
165: U[K,2]+.667*r9*100^r17→r5
166: T[H]*M[2]*S[K,2]/(π*r4*r5)→N[K]
167: "K3600":
168: "MUN. EXP. CALS.":
169: if I>2;gto "K4010"
170: "INITL. SHELL SPAC. FOR HC SMK.":
171: G*45→r12
172: "SUST. SHELL SP. FOR HC SMK.":
173: if C[1,1]#0;gto "K3700"
174: 0→Y[H,I,K];gto "K3800"
175: "K3700":
176: for L=1 to 7
177: 1/r18*(.731*T[K]*M[1]*S[K,1]/(C[1,1]*G*r9))^r11→Y[H,I,K]
178: if Y[H,I,K]>A[L];A[L]→Y[H,I,K]
179: "K3800":
180: if Y[H,I,K]=0;1→P→Q[H,I,K];gto "K4000"
181: if r12>Y[H,I,K];Y[H,I,K]→r12
182: "INITL. VOLY. FOR HC SMK.":
183: A[L]/r12→P
184: if frc(P)>0;int(P)+1→P
185: "NUM. OF GUNS FOR SUST. VOLYS. (HC)":
186: A[L]/Y[H,I,K]→Q[H,I,K]
187: if frc(Q[H,I,K])>0;int(Q[H,I,K])+1→Q[H,I,K]
188: "RATE OF FIRE FOR HC SMK.=0.5":
189: "K4000":
190: for M=1 to 4
191: "TOTL. NUM. OF RNDS. REQD. (HC)":
192: P+(.5*W[L,M]-1)*Q[H,I,K]→P[K,I,H,L,M]
193: if frc(P[K,I,H,L,M])>0;int(P[K,I,H,L,M])+1→P[K,I,H,L,M]
194: if K=1;if P[1,I,H,L,M]/(6*W[L,M])>3.1;1000→P[1,I,H,L,M]
195: if K=2;if P[2,I,H,L,M]/(6*W[L,M])>1.1;1000→P[2,I,H,L,M]
196: if L>5;gto "K5050"
197: "K4010":
198: if I<3;if H>4;gto "K4200"
199: "SHELL SPAC.(Z[ ]) & VOLYS (r13) - WP SMK.":
200: if C[1,2]#0;gto "K4020"
201: 0→Z[H,I,K]→r13;gto "K4080"
202: "K4020":
203: if I>2;.6*C[1,2]/N[K]→r13;gto "K4040"
*32690
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204: if C[1,2]=0;gto "K4100"
205: N[K]/C[1,2]*100→Z[H,1,K]
206: if Z[H,1,K]>O[L];O[L]→Z[H,1,K]
207: O[L]/Z[H,1,K]→r13
208: "K4040":
209: int(r13)→r1
210: if frc(r13)>0;r1+1→r13
211: "RATE OF FIRE FOR WP SMK.":
212: "K4080":
213: if I>2;120/V[H]→r19;gto "K4090"
214: (Z[H,1,K]+60)/V[H]→r19
215: "K4090":
216: r19/20→r19
217: int(r19)→r1
218: if frc(r19)>=.5;r1+1→r1
219: if r1=0;1→r1
220: r1*20/60→r19
221: 1/r19→r19
222: if r19<1;1→r19
223: "K4100":
224: "TOTL. NUM. OF RNDS. REQD. (WP)":
225: if C[1,2]=0;0→P[K,2,H,L,M];gto "K5050"
226: if I<3;(X[L,M]*r19-1)*r13+r13→P[K,2,H,L,M]
227: if I>2;r13*(O[L]/60+1)*(X[L,M]*r19-1)→P[K,2,H,L,M]
228: int(P[K,2,H,L,M])→r1
229: if frc(P[K,2,H,L,M])>0;r1+1→P[K,2,H,L,M]
230: gto "K5000"
231: "K4200":
232: "CAL. FOR E & F STAB CAT":
233: "INITL SHELL SPAC. - WP SMK.":
234: if I=1;if K=1;100→r14
235: if I=2;if K=1;50→r14
236: if I<3;if K=2;100→r14
237: "INITL VOLY FOR WP SMK":
238: O[L]/r14+1→r15
239: "SUST SHL SPAC - WP SMK":
240: 0→r14
241: if I=1;if K=1;100→r14
242: if I=1;if K=2;200→r14
243: if I=2;if K=1;50→r14
244: if I=2;if K=2;100→r14
245: "SUST VOLY - WP SMK":
246: O[L]/r14+1→r16
247: "RATE OF FIRE FOR WP SMK":
248: if K=1;2→r19
249: if K=2;1→r19
250: "TOTL NUM OF WP RNDS REQ":
251: r15+r16*(r19*X[L,M]-1)→P[K,2,H,L,M]
252: "K5000":
253: if K=1;if P[1,2,H,L,M]/(6*X[L,M])>3.1;1000→P[1,2,H,L,M]
254: if K=2;if P[2,2,H,L,M]/(6*X[L,M])>1.1;1000→P[2,2,H,L,M]
*22417
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255: "K5050":
256: next M
257: next L
258: next K
259: next H
260: fmt 3/;wrt 701
261: if Q=15;1→A
262: if Q=40;28→A
263: if Q=80;55→A
264: fmt 1,27x,"VOLUME OF FIRE TABLE - HC SMOKESCREEN;",1x,c27
265: wrt 701.1,H$[A,A+26]
266: 1→B
267: for K=1 to 2
268: fmt 1,"SCREEN(M)",c112,z;wrt 701.1,A$[1,112]
269: fmt 1,/," MINUTES ",c112;wrt 701.1,W$[1,112]
270: fmt 1,"STABILITY",44x,c3,"mm HOWITZER ",z;wrt 701.1,B$[B,B+2]
271: 1→D
272: 4→B
273: for H=1 to 6
274: fmt 1,/,c9,z;wrt 701.1,G$[D,D+8]
275: for L=1 to 7
276: for M=1 to 4
277: fmt 1,z,1x,f3.0;wrt 701.1,P[K,1,H,L,M]
278: next M
279: next L
280: D+9→D
281: next H
282: fmt 1,2/;wrt 701.1
283: next K
284: gsb "NOTES HC"
285: fmt 2,21/;wrt 701.2
286: fmt 1,27x,"VOLUME OF FIRE TABLE - WP SMOKESCREEN;",1x,c27
287: wrt 701.1,H$[A,A+26]
288: 1→B
289: for K=1 to 2
290: fmt 1,16x,"SCREEN(M)",c80;wrt 701.1,O$[1,80]
291: fmt 1,16x," MINUTES ",c80;wrt 701.1,X$[1,80]
292: fmt 1,16x,"STABILITY",33x,c3,"mm HOWITZER",z;wrt 701.1,B$[B,B+2]
293: 1→D
294: 4→B
295: for H=1 to 6
296: fmt 1,/,16x,c9,z;wrt 701.1,G$[D,D+8]
297: for L=1 to 5
298: for M=1 to 4
299: fmt 1,z,1x,f3.0;wrt 701.1,P[K,2,H,L,M]
300: next M
301: next L
302: D+9→D
303: next H
304: fmt 1,2/;wrt 701.1
305: next K
*24082
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306: gsb "NOTES WP"
307: fmt 1,12/;wrt 701.1
308: "K5300":
309: next I
310: gsb "DONE"
311: end
312: "NOTES HC":
313: fmt 1,4/;wrt 701.1
314: if I=1;gto "K5400"
315: if I=2;gto "K5500"
316: "K5400":
317: fmt 1,35x,"1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7"
318: wrt 701.1;fmt 2,38x,"MICROMETERS.";wrt 701.2
319: fmt 1,/;wrt 701.1
320: gto "K5600"
321: "K5500":
322: fmt 1,35x,"1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5";wrt 701.1
323: fmt 1,38x,"MICROMETERS.";wrt 701.1
324: fmt 1,/;wrt 701.1
325: "K5600":
326: fmt 1,35x,"2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND."
327: wrt 701.1
328: fmt 1,38x,"FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS"
329: wrt 701.1
330: fmt 1,38x,"BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY"
331: wrt 701.1
332: fmt 1,38x,"EXTRACTED NUMBER OF ROUNDS BY 2.6";wrt 701.1
333: fmt 1,/;wrt 701.1
334: fmt 1,35x,"3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY;"
335: wrt 701.1;fmt 1,38x,"WIND SPEED IN KNOTS.";wrt 701.1
336: fmt 1,/;wrt 701.1
337: fmt 1,35x,"4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCEED RATE OF"
338: wrt 701.1
339: fmt 1,38x,"FIRE OF WEAPON/BATTERY.";wrt 701.1
340: fmt 1,/;wrt 701.1
341: fmt 1,35x,"5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.";wrt 701.1
342: ret
343: "NOTES WP":
344: fmt 1,4/;wrt 701.1
345: if I=1;gto "K6400"
346: if I=2;gto "K6500"
347: "K6400":
348: fmt 1,35x,"1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7"
349: wrt 701.1;fmt 1,38x,"MICROMETERS.";wrt 701.1
350: fmt 1,/;wrt 701.1
351: gto "K6800"
352: "K6500":
353: fmt 2,35x,"1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5";wrt 701.2
354: fmt 1,38x,"MICROMETERS.";wrt 701.1
355: fmt 1,/;wrt 701.1
356: "K6800":
*6376
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357: fmt 1,35x,"2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND."
358: wrt 701.1
359: fmt 1,38x,"FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT"
360: wrt 701.1
361: fmt 1,38x,"DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.";wrt 701.1
362: fmt 1,/;wrt 701.1
363: fmt 1,35x,"3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY;"
364: wrt 701.1;fmt 1,38x,"WIND SPEED IN KNOTS.";wrt 701.1
365: fmt 1,/;wrt 701.1
366: fmt 1,35x,"4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF"
367: wrt 701.1
368: fmt 1,38x,"FIRE OF WEAPON/BATTERY.";wrt 701.1
369: fmt 1,/;wrt 701.1
370: fmt 1,35x,"5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.";wrt 701.1
371: ret
372: "FNA":ret exp(-r6*p1/2)
373: "FNB":ret exp(-p1^2)
374: "FNC":ret exp(p1*r6*ln(.1/F[1]))
375: "FND":ret exp(-p1*r6/4.1)
*1236
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